

NASA Contractor Report 3922(09)

## USSR Space Life Sciences Digest

*Issue 8*

*Edited by*

Lydia Razran Hooke, Mike Radtke,  
Victoria Garshnek, and Ronald Teeter

*Management and Technical Services Company  
Washington, D.C.*

Joseph E. Rowe

*Library of Congress  
Washington, D.C.*

Prepared for  
NASA Office of Space Science and Applications  
under Contract NASW-3676



National Aeronautics  
and Space Administration

**Scientific and Technical  
Information Branch**

1986

## CONTENTS

Reader Feedback Form .....	v
FROM THE EDITORS .....	vi
ADAPTATION .....	1
BIOLOGICAL RHYTHMS*.....	2
BIOSPHERICS .....	2
BODY FLUIDS .....	7
BOTANY.....	12
CARDIOVASCULAR AND RESPIRATORY SYSTEMS.....	16
COSMONAUT TRAINING* .....	23
CYTOLOGY* .....	23
ENDOCRINOLOGY* .....	23
ENZYMOLGY .....	23
EQUIPMENT AND INSTRUMENTATION .....	25
EXO BIOLOGY .....	26
GASTROINTESTINAL SYSTEM .....	32
GENETICS .....	36
GROUP DYNAMICS .....	38
HABITABILITY AND ENVIRONMENT EFFECTS .....	39
HEMATOLOGY .....	40
HUMAN PERFORMANCE .....	43
IMMUNOLOGY .....	53
LIFE SUPPORT SYSTEMS .....	55
MAN-MACHINE SYSTEMS* .....	60

\* Topics marked with \* have no entries of their own, but refer readers to relevant abstracts included in other topic areas.

USSR SPACE LIFE SCIENCES DIGEST

NUMBER 8

MATHEMATICAL MODELING*	60
METABOLISM	60
MICROBIOLOGY*	63
MUSCULOSKELETAL SYSTEM	63
NEUROPHYSIOLOGY	64
NUTRITION	76
OPERATIONAL MEDICINE	78
PERSONNEL SELECTION*	84
PSYCHOLOGY	84
RADIOBIOLOGY	85
REPRODUCTIVE BIOLOGY*	96
SPACE BIOLOGY AND MEDICINE	96
ENGLISH TRANSLATIONS OF SOVIET SPACE LIFE SCIENCES BOOKS AVAILABLE TO OUR READERS	100
MEDICAL PROCEDURES PERFORMABLE ON SOVIET SPACECRAFT	101
CURRENT TRANSLATED SOVIET LIFE SCIENCE MATERIALS AVAILABLE TO OUR READERS	103

\* Topics marked with \* have no entries of their own, but refer readers to relevant abstracts included in other topic areas.

USSR Space Life Sciences Digest: Number 1    Reader Feedback Form

To our readers: We are working in a large number of highly technical, specialized areas for which adequate Russian-English glossaries have yet to be compiled. We ask your help in improving the accuracy and specificity of our English terminology. Please fill out the form below whenever you encounter an incomprehensible, incongruous, awkward or otherwise inappropriate term. While we solicit all suggestions for improved renderings, the statement that a term is inappropriate provides us with useful information, even when no better alternative can be suggested. A copy of this form will appear in all future issues of the Digest. Thank you for your help.

Abstract #	Incorrect or contextually  inappropriate word or  phrase:	Suggested rendering:  ("??" is an acceptable  entry)
------------	---	--

--	--	--

PLEASE RETURN TO: Dr. Lydia Hooke  
Management and Technical Services Company  
600 Maryland Ave. SW  
Suite 209, West Wing  
Washington, DC 20024

## FROM THE EDITORS

This is the eighth issue of the USSR Space Life Sciences Digest, which incorporates a few minor changes in format: first, the first number in parentheses in each abstract designation (i.e., the number preceding "/86") will henceforth refer to Digest Issue #, and not to month of issue submission, as it did previously. Second, in accordance with NASA research classification terms, the category previously called "HEALTH AND MEDICAL TREATMENT" will now be designated "OPERATIONAL MEDICINE." Third, a new category, "EQUIPMENT AND INSTRUMENTATION," has been added as a rubric for previously unclassifiable space life sciences articles. Attention is called to the announcement of the English translations of two Soviet space life sciences books, which will interest many of our readers. We would like to acknowledge the invaluable help of Mr. Tim Rowe of NASA's Scientific and Technical Information Facility, who has been responsible for keeping us informed about the availability of translated books.

Please address correspondence to:

Dr. Lydia Hooke  
Management and Technical Services Company  
600 Maryland Ave. SW  
Suite 209, West Wing  
Washington, DC 20024

### ADAPTATION

[See also: Body Fluids: M88; Human Performance: P355; Metabolism: M89;  
Neurophysiology: P339]

#### MONOGRAPH:

M87(8/86) Agadzhanyan NA, editor.

Adaptatsiya cheloveka i zhivotnykh k ekstremal'nykh usloviyam  
vneshney sredy: Sb. nauchnykh trudov

[Adaptation of humans and animals to extreme environmental conditions].

Moscow: Isdatel'stvo Universiteta druzhby narodov; 1985.

[184 pages; 13 tables; 61 figures; 255 references; 91 in English]

Affiliation: University of Friendship Among Peoples, Moscow

**Key Words:** Adaptation, Biorhythms, Hypoxia, Hyperthermia, Physical  
Exertion, Cardiovascular System

Annotation: This collection contains theoretical and experimental material  
examining various aspects of the adaptive process in biological systems at  
various levels of organization. Emphasis is placed on human adaptation to  
various environmental conditions -- hypoxia, hypercapnia, and physical  
exertion. Other topics include the effects of various environmental  
factors on biological rhythms at the cellular and organismic levels.  
Indicators of the tolerance of individual animals to extreme factors are  
analyzed. This book is intended for physiologists and ecologists  
interested in adaptation and chronobiology.

### CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

Bashkirov AA. Physiological mechanisms underlying adaptation to hypoxia (10)

Shchel'tsyn LK. Corticofugal effects on the reticular formation and cardiac  
rhythm (28)

Aleksandrova SS, Shevchenko LV, Yelfimov AI. Morphological and functional  
indicators of the tolerance of individual animals to hypoxia (57)

Agadzhanyan NA, et al. Characteristics of regulation of the  
cardiorespiratory system during adaptation of humans to a hot climate (82)

Lizunova II. Characteristics of thermal regulation of inhabitants of  
various climatic regions during adaptation to a moderate climate (98)

Eshchenko VV. The functioning of the human body during prolonged work  
under extreme conditions in caves (117)

Agadzhanyan NA, Vlasova IG, Alpatov AM. Adaptation and biorhythms (138)

BIOLOGICAL RHYTHMS: See Adaptation: M87; Operational Medicine: P324

### **BIOSPHERICS**

[See also: Exobiology: M92]

#### **MONOGRAPHS:**

M95(8/86) Gerasimov IP.

**Geographical Prognostication: Problems and Prospects.**

Moscow: Progress; 1986.

Affiliation: USSR Academy of Sciences.

NB: This book was published in **English**. At present, we have uncovered no reliable source of copies. When we do succeed in finding one, we will notify our readers. Annotation and contents are reproduced, with stylistic revisions, from the English original.

**Key Words:** Biospherics, Geographical Predictions, Climate, Ecology

Annotation: The growing pressure exerted by human activity on the biosphere makes the interaction between various biospheric components and Earth's mantle increasingly complex, with some areas showing signs of impending ecological crisis. Virtually all nations have realized the seriousness of this problem.

This explains why, throughout the world, geographical science has focused on the social consequences of the relationship between man and nature, and on how this relationship influences prediction of the geographical future. Such geographical prognostication involves predictions of future trends in geographical science itself, as well as of the future development of the landscape mantle and its individual components and subsystems. Although geographical prognostication has so far fallen far short of society's need for such information, Soviet geographers have been cited at many international conferences on geography as being outstanding contributors to this field.

The articles in this collection present Soviet research in the field of geographic prognostication by authors who include such leading exponents of Soviet geographical science as I. Gerasimov, S. Schwartz, and F. Davitaya, full members of the USSR Academy of Sciences, and M. Budyko and V. Kotlyakov, corresponding members of the Academy.

### **CONTENTS**

(Numbers in parentheses refer to page numbers in the original.)

[Chapter headings are rendered as published.]

Introduction (5)

Problems in long-term geographical prognostication. T. Zvonkova, Yu. Saushkin (11)

Prognostication and geographical science. D. Armand, I. Gerasimov, V. Preobrazhenskiy (23)

## BIOSPHERICS

M95

[The] scientific and technological revolution and Soviet geography. I. Gerasimov, with V. Annenkov, F. Davitaya, O. Konstaninov, Ya. Mashbits, V. Pokshishevskiy, V. Preobrazhenskiy, A. Ryabchikov.

Theoretical principles of global ecological prognostication. S. Schwartz (49)

Coming changes in the climate. M. Budyko, K. Vinnikov, O. Drozdov, N. Yefimova (62)

Future changes in the climate and the future of glaciers. M. Grosswald, V. Kotlyakov (80)

Technogenesis and the problems of geochemical landscape prognostication. M. Galzovskaya (94)

Geographical aspects of prognostication of the environment outside the Soviet Union. Yu. Yermakov, A. Ryabchikov, V. Solntsev (103)



## BIOSPHERICS

### CONFERENCE REPORT

CR3(8/86)Vedeshin LA, Yegorov VV.

**International collaboration in the "Interkosmos" Program for the study of the Earth from space** (in honor of the 10th anniversary of the working group of socialist nations on remote sensing of the Earth)

In: Issledovaniye Zemli uz Kosmosa.

1986(3): 117-119.

**Key Words:** Biospherics, Interkosmos, Remote Sensing, Multispectral Photographs, Salyut-6, Salyut-7

[Article translated in full.]

On 1-5 October 1985 the XVIIIth regular meeting of the leaders of the national coordinating agencies of the nations participating in the "Interkosmos" program, was held in Moscow, as mandated in the Agreement for Collaboration in Research on and Utilization of Space for Peaceful Purposes.

Participants at the meeting discussed and approved the major results of the activities of the Working Group of Socialist Nations on Remote Sensing of the Earth (RSWG), the plan for joint research and experiments in remote sensing for 1986-1990, as well as a multidisciplinary project -- "Priroda" [Nature] -- which requires the development of a super high frequency radiometric complex, an infrared spectroradiometric complex ("Istok-1"), and a multichannel spectroradiometric instrument for the study of the Pacific Ocean, the atmosphere and the Earth's mantle.

In 1985 the RSWG marked its 10th anniversary. At its first meeting, which took place in April 1975 in Baku, members adopted a program and plan for scientific research, and defined the organization of the working group. The activities of the RSWG are divided into 3 sections which are further divided into 9 research thrusts. Each annual meeting of the RSWG, which takes place on a rotating basis in each of the participant nations, is devoted to discussion of the scientific program and annual work plans and to presentation of scientific papers and reports on the results of experiments and research performed during the year.

During its first 10 years, the RSWG developed and implemented a number of international scientific and technological projects of methodological and practical importance. Specialists from the USSR and GDR developed a new method and new instrumentation for obtaining multispectral space photographs of the Earth's surface. The multispectral space apparatus MKF-6, which successfully passed its flight tests in the "Raduga" [Rainbow] experiment on the "Soyuz-22" manned spacecraft in September 1976, together with the MSF-4 multichamber synthesizing projector for processing multispectral photographs, were manufactured in the "Karl Heine" national enterprise in GDR. The modified MSF-6M apparatus was used on board the "Salyut-6" and "Salyut-7" stations. Multispectral photographs obtained with the MSF-6M were used by 195 organizations within 16 ministries and departments of the USSR. The MSK-4, an aircraft analogue of the MSF-6, was used extensively in the aircraft laboratories of the socialist nations. The MKF-6M and MSK-4 were used in multidisciplinary aerospace experiments on the scientific proving ground (test bed) of

## BIOSPHERICS

CR3

Bulgaria, Hungary, Viet Nam, GDR, Cuba, Mongolia, Poland, USSR and Czechoslovakia. The results of the experiments performed using the MKF-6 apparatus were presented in a number of books: "'Soyuz-6' Studies the Earth" (USSR, Bulgaria), "Remote Sensing of the Earth from Space" (USSR, GDR), "'Salyut-6' Studies the Biosphere" (USSR, Hungary), the atlas "Decoding Aerospace Photographs of Earth. Methodology and Results" (USSR, GDR), a map of the contour lines and ring structures of the socialist nations, and also a number of joint scientific and technological reports on completed experiments and programs.

In the period between 1978 and 1981, international crews from the socialist nations participated in remote sensing experiments on the "Salyut-6" space station. The RSWG was responsible for developing the "Spektr-15" spectrometer (Bulgaria) and the small cameras "Praktika-EE2" and "Pentakon-6" (Germany) for these experiments, as well as for the research methodology and program. Concurrently with the surveys made from the "Salyut-6" station of the territories of the nations participating in the international flights, subsatellite observations and measurements were recorded of spectral, physical and biochemical characteristics of natural formations. The experiments begun on the "Salyut-6" were continued on the "Salyut-7," using the "Spektr-15M," "Praktika-B200," MKF-6M and MKS-M spectrometer.

In addition to the work performed on the "Salyut" stations, the RSWG was responsible for experiments related to the Pacific ocean, and ice and snow cover, as well as for monitoring of the atmosphere in the visible and super high frequency bands of the spectrum from the unmanned "Interkosmos-20" (1979) and "Interkosmos-21" (1981) satellites. The on-board equipment included the MKS spectrometer (GDR and USSR), the P-225 super high frequency radiometer (USSR) and the SG-R magnetometer (Romania, USSR), and also the SSPI system for gathering and transmitting information (Hungary, GDR, USSR, Czechoslovakia). The ground-based portion of the SSPI system consisted of buoys and platforms. Specialists from Bulgaria, GDR, USSR and Czechoslovakia compiled the collection "Results of Experiments on the 'Interkosmos-20' and '-21', published in GDR in 1984, as well as a series of publications in their own and Western journals.

In 1980, an experiment with the "Fragment" multispectral scanning system (MSS) was begun on the "Meteor" satellite. This apparatus was developed at the Institute of Space Research of the USSR Academy of Sciences, with the participation of specialists from GDR, who developed the reflecting lens. Processing of information obtained with the "Fragment" MSS was performed by specialists from Bulgaria, Hungary, GDR, Poland, Roumania, USSR, and Czechoslovakia. During the period from 1980-1984 a large volume of information was obtained with the "Fragment" MSS from the "Meteor" satellite. Specialists from the GDR, USSR and Bulgaria are now using this information to compile a second volume of the atlas, "Decoding of Multispectral Aerospace Photographs."

In 1981, to commemorate the 1300th anniversary of the establishment of the Bulgarian state, specialists from Bulgaria and the USSR performed a space experiment on the study of the Earth's natural resources from the "Meteor-Priroda" satellite, using the "Tangra" system. This system included the SMP-32, a Bulgarian 32-channel spectrometer for the visual and infrared

## BIOSPHERICS

CR3

bands, the Bulgarian RM-1 super high frequency radiometer (4 cm), as well as the Soviet RM-2 super high frequency radiometer (0.8, 1.35 and 1.6 cm) and the Soviet MSU-S intermediate resolution scanner. Information from the latter instrument is transmitted to autonomous reception points in Sofia and Moscow. During the period the satellite was in operation, from 1981 to 1983, Bulgarian and Soviet specialists obtained a large volume of scientific information, in particular, several million spectograms of solar radiation reflected from the Earth's surface in an area extending from the Polar Circle to North Africa and from the Alps to the Urals, and also spectra of the super high frequency radiation emitted by the Earth's surface. The results of this experiment were presented in a collection of scientific papers "Remote Sensing of the Earth from the 'Meteor -- Priroda' satellite."

In recent years there has been a tendency in the RSWG to move away from individual space or aircraft-based experiments toward large scale international projects in the study of geosystem dynamics, the Pacific Ocean, and closed bodies of water, and also of geological formations and processes. Such an approach facilitates identification of the spatial-temporal dynamics of development and interaction among the natural entities forming geosystems. In 1983-1985, this program included international, interdisciplinary aerospace experiments such as "Black Sea-83, -84 and -85," "Gyunesh-84" and "Kursk-85." A great deal of experience was gained in the implementation and management of multidisciplinary, multilevel experiments, and a theoretical basis for studying various types of geosystems was developed and tested. The data from these experiments are currently being processed by specialists of the nations cooperating in "Interkosmos."

The work plans for the next 5-year period stipulate a continuation of research within the framework of international, multidisciplinary, goal-directed projects and programs to develop new technology for obtaining and processing information, to improve and optimize methods for thematic processing and interpretation of remote sensing data.

All these issues were examined and discussed thoroughly at the XIth meeting of the RSWG (Havana, 12-18 May 1985). A resolution was adopted at that session to develop in 1986-1990 a large international scientific-technological project leading to the creation of a super high frequency radiometric system, an "Istok-1" infrared system, a spectrometric apparatus of the MKS type and an onboard system for numerical data processing. In addition, at this meeting the Soviets proposed that facilities be established in the nations participating in the RSWG for receiving scientific information obtained with a side-looking radar and low resolution MSU-M type scanner from the "Kosmos-1500 and -1602" satellites, and jointly processing and interpreting this data.

A scientific seminar and exhibition of "Techniques and Technology for Remote Sensing of the Earth" are planned for the up-coming XIIth meeting of the RSWG (Tallin, 12-18 May, 1986).

## BODY FLUIDS

[See also: Life Support Systems: M91]

### PAPER:

P348(8/86) Terenozhkina NP.

**The effect of natriuretic hormone on ion transport through the erythrocyte membrane.**

Kardiologiya.

XXVI(3): 87-90; 1986.

[14 references; 7 in English]

Affiliation: Department of Pharmacology, Chernovits Medical Institute.

Body Fluids, Ion Transport; Cytology, Cell Membrane

Dogs

Endocrinology, Natriuretic Hormone

**Abstract:** In this study natriuretic hormone was isolated from arterial blood of dogs. Two peptide fractions demonstrating natriuretic activity were obtained after gel filtration. Erythrocytes were obtained from the blood of healthy donors which had been incubated in a solution containing NaCl, KCl,  $MgCl_2$ ,  $CaCl_2$ , glucose, and tris-HCl-buffer. Natriuretic hormone was added to the erythrocyte suspension, incubated for 30 minutes, and centrifuged at 3000 g. The supernatant liquid was decanted and the concentration of sodium and potassium in it determined. The sediment was then washed with tris-HCl-buffer, the erythrocytes hemolyzed with distilled water and the concentrations of sodium and potassium determined using flame photometry. Erythrocyte ghosts were created by precipitating erythrocytes from the blood of healthy donors, washing, hemolyzing and centrifuging at 18000 g. ATP and  $Mg^{2+}$  were added to the solution during hydrolysis to study active ion transport through the cell membrane of the ghost. The erythrocyte ghosts were restored by adding a solution of NaCl, KCl,  $MgCl_2$ , and ATP to the precipitate, and mixing rapidly. In some experimental conditions, the sodium and potassium in the solution were replaced with choline chloride. This suspension was kept for 10 minutes in the cold and incubated with natriuretic hormone (quantity not specified) for 30 minutes. After centrifugation, the concentrations of sodium and magnesium in the precipitate and supernatant were determined. The natriuretic hormone was either introduced into the cell during hemolysis or added to the incubating solution, depending on the experimental condition. Protein content was also measured. The ratio of the amounts of sodium or potassium in the supernatant to concentrations of these elements in the erythrocytes or ghosts was computed. The ratio of the quantity of calcium to the quantity of potassium in the erythrocytes and ghosts was also computed.

Introduction of natriuretic hormone into a solution containing erythrocytes, calcium and potassium increased the quantity of calcium and decreased the amount of potassium in the erythrocytes. Because of this, the ratio of sodium to potassium increased from 1.5 in the baseline (no hormone present) to 2.7 in the experimental condition. When the erythrocyte ghosts were used, it was possible to study the effects of both the intracellular and the extracellular hormone. In the first series of experiments, natriuretic hormone was introduced into the ghosts as well as into the solution in which they were incubated. The presence of the hormone inhibited the entry of potassium into the cell. A similar

## BODY FLUIDS

P348

incubation solution with potassium omitted, led to inhibition of the passage of calcium into the cell. This effect of natriuretic hormone was analogous to that of k-strophanthin. When choline chloride, as well as natriuretic hormone, was added to the solution in which the ghosts were incubated, sodium was retained within the cells, but no change in potassium was noted.

The next series of experiments, examined only the effects of natriuretic hormone applied to the outer surface of the erythrocyte ghosts. When the hormone was introduced into a solution with sodium and potassium, the amount of potassium in the ghosts decreased. There was also an increase in the ratio of  $\text{Na}^+$  to  $\text{K}^+$ . When  $\text{K}^+$  ions were excluded from the incubation solution, the quantity of sodium was altered. The author concludes that natriuretic hormone operating on the outside of the cell membrane alters ion transport analogously to K-strophantine.

Tables and Figure: Table 1: Ratio of the quantity of sodium and potassium in erythrocyte ghosts with natriuretic hormone acting on both the inside and the outside of the cell membrane

Solution	Condition	Ratio		
		$\frac{\text{Na}^+ \text{ precip.}}{\text{K}^+ \text{ precip.}}$	$\frac{\text{Na}^+ \text{ super.}}{\text{Na}^+ \text{ precip.}}$	$\frac{\text{K}^+ \text{ super.}}{\text{K}^+ \text{ precip.}}$
With $\text{Na}^+$ and $\text{K}^+$	Control	1.4	4.6	1.1
	Exper.	3.1	4.8	3.1
	p	< 0.001	n.s.	< 0.05
Without $\text{K}^+$	Control	9.0	1.7	0.2
	Exper.	5.0	2.6	0.2
	p	< 0.001	< 0.01	n.s.

Table 2: Ratio of sodium and potassium with natriuretic hormone acting only on the outside surface of the cell membrane

Solution	Condition	Ratio		
		$\frac{\text{Na}^+ \text{ precip.}}{\text{K}^+ \text{ precip.}}$	$\frac{\text{Na}^+ \text{ super.}}{\text{Na}^+ \text{ precip.}}$	$\frac{\text{K}^+ \text{ super.}}{\text{K}^+ \text{ precip.}}$
With $\text{Na}^+$ and $\text{K}^+$	Control	1.5	3.1	0.7
	Exper.	1.9	3.2	1.4
	p	< 0.002	n.s.	< 0.001
Without $\text{K}^+$	Control	65.5	1.6	1.6
	Exper.	51.1	1.9	1.4
	p	< 0.001	< 0.01	n.s.

P348

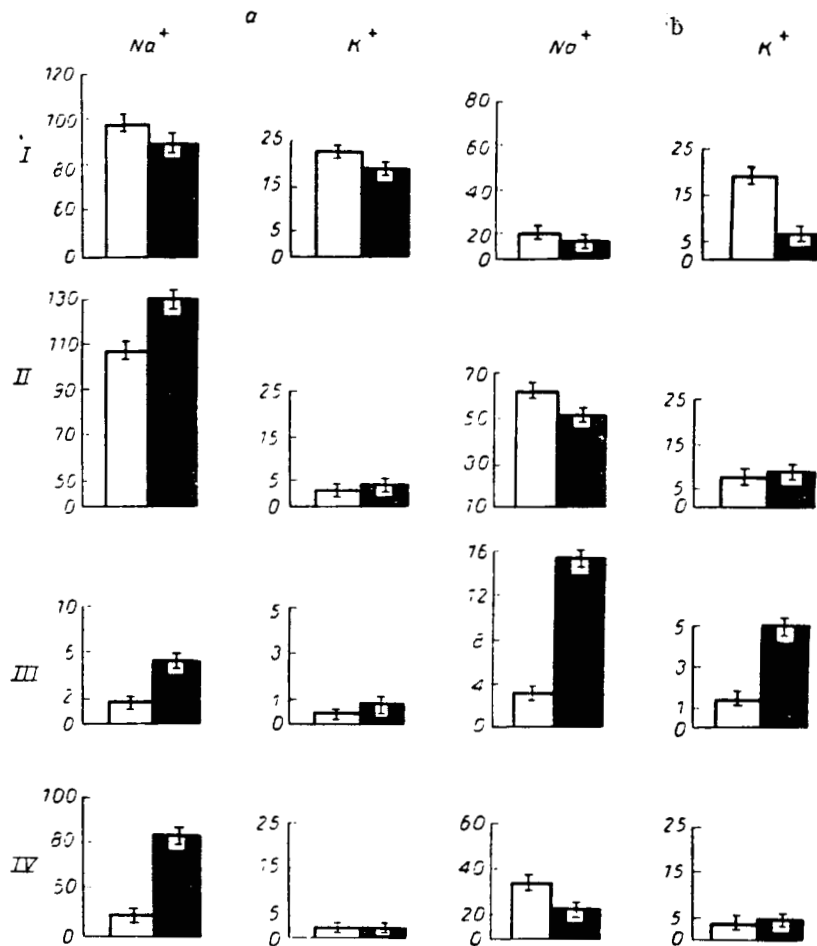


Figure: Effect of natriuretic hormone on ion transport through cell membrane. Light bars -- control; Dark bars -- experimental. Ordinate -- quantity of sodium and potassium (in moles); I - incubation of ghosts in solution containing calcium and potassium ions; II - in solution without potassium; III - in solution containing choline chloride; IV -- in solution without potassium and with strophanthine. a - supernatant; b - precipitate.

**MONOGRAPH:**

M88(8/86) Gazenko OG. Grigor'yev AI , Natochin YuV.

Vodno-Solevoy Gomeostaz i Kosmicheskiy Polet.

**[Fluid-Electrolyte Balance and Space Flight].**

Volume 54 in Series: Problemy Kosmicheskoy Biologii [Problems in Space Biology]

Moscow: Nauka; 1986.

[63 tables; 64 figures; 22 pages of illustrations]

**Key Words:** Fluid-electrolyte Metabolism, Endocrinology, Spaceflight, "Voskhod," "Soyuz," "Salyut," "Kosmos," Adaptation, Weightlessness Simulation, Countermeasures, Renal Function

**Annotation:** This book summarizes 20 years of research on fluid-electrolyte metabolism in members of the crews of the "Voskhod" and "Soyuz" spacecraft and the "Salyut" orbital stations, as well as experiments performed on the biosatellites of the "Kosmos" series. Emphasis is placed upon the development and utilization of provocative stress tests in the study of fluid and electrolyte metabolism under extreme conditions. The role of endocrine factors in adaptation to weightlessness and readaptation to Earth's gravity is analyzed. The results of ground-based simulations of the effects of space flight factors on fluid-electrolyte balance, and renal function are discussed. Data relevant to the effectiveness of various countermeasures directed at changes in the regulation of fluid-electrolyte metabolism under such conditions are presented. This book is intended for physicians, biologists, physiologists, and specialists in aerospace medicine.

**CONTENTS**

(Numbers in parentheses refer to page numbers in the original.)

Introduction (5)

Chapter 1. Characteristics of fluid-electrolyte metabolism and renal function during space flight (7)

Electrolyte concentration in blood plasma (7)

Changes in body weight and fluid-electrolyte balance in flight (11)

Excretion of fluid and electrolytes during space flight (18)

Renal excretion of fluid and electrolytes postflight (27)

The osmoregulatory function of the kidneys (27)

Chapter 2. Utilization of stress tests to evaluate renal function and fluid-electrolyte metabolism (34)

Fluid loading test (40)

Osmotic concentration in the kidneys (53)

Electrolyte loading (55)

Chapter 3. Fluid-electrolyte metabolism in animals on the biosatellites (67)

## BODY FLUIDS

M88

- Chapter 4. Fluid-electrolyte exchange in response to simulated effects of individual space flight factors (78)
  - Immersion (78)
  - Bed rest with head-down tilt (84)
  - Responses to fluid and electrolyte loading (90)
  - The effects of the duration of hypokinesia on fluid-electrolyte metabolism (106)
- Chapter 5. The state of the system regulating fluid-electrolyte metabolism during space flight and weightlessness simulations (122)
  - The acute period of adaptation to weightlessness (123)
  - Long-term exposure to weightlessness and hypokinesia (132)
  - The acute period of adaptation after landing (143)
- Chapter 6. Countermeasures for changes in fluid-electrolyte metabolism in space flight (160)
  - The conditioning effects of lower body negative pressure (160)
  - Physical training during long-term bed rest (172)
  - The effects of low centrifugal force (185)
  - Administration of liquids, sodium chloride and hormones for increasing tolerance of postural effects (194)
  - Utilization of various countermeasures to prevent disruption of fluid-electrolyte metabolism in space flight (208)
- Conclusion (208)
- References (216)



## BOTANY

[See also: Life Support Systems: P353; Radiobiology: P359, P360]

### PAPERS:

P312(8/86) Vaulina, EN, Anikeyeva ID, Kostina LN.

#### **The viability and mutability of plants after space flight.**

In: Kovrov BG, Kordum VA, editors.

Mikroorganizmy v iskusstvennykh ekosistemakh.

[Microorganisms in artificial ecosystems].

Moscow: Nauka; 1985.

[Pages 5-10; 10 references; 4 in English]

See also Digest Issue 7: M78; Digest Issue 6: P235.

Botany, Viability; Genetics, Mutability

Arabidopsis thaliana, Crepis capillaris

Space Flight, "Salyut-6," "Salyut-7"

Abstract: Three experiments are described in this paper. In the first, air-dried seeds of Arabidopsis thaliana and Crepis capillaris were flown in hermetically sealed containers on board the "Salyut-6" and "-7" space stations for 49, 201, 226, 408, and 827 days. After return to Earth, the seeds were planted and studied using standard methods. Decreases in germination rate, viability and fertility of the plants, as well as increases in their mutability were found to be directly related to the length of time they were stored on the ground and in flight. However, these effects were more pronounced for the plants exposed to space. Noticeable morphological changes occurred only in those plants which died at various stages of development. In the second experiment, Crepis capillaris seeds were germinated either in space or on the ground after having been flown in space for 3 to 234 days. The resulting shoots were analyzed for chromosomal rearrangements. The frequency of rearrangements was greater for the seeds germinated in flight than for the seeds which had never flown or which had been germinated after return to Earth. [See Digest Issue 6: P235]. In the third experiment, Arabidopsis thaliana and Crepis capillaris plants were grown under space flight conditions in either the "Fiton" or "Svetoblok" apparatus. The phototropic response and morphology of the vegetative and generative organs of the flight plants did not differ from those of controls. Plants grown in the "Svetoblok" did not bear seeds in space; however, they flowered and bore fruit on Earth. The fertility of the resulting seeds was significantly lower than that of control seeds. The plants grown in the Fiton apparatus did bear seeds in space. Analysis of the plants grown from these seeds showed an increased mutation rate, although fertility did not differ from control levels. In both of the types of seeds studied, all the parameters (germination rate, viability, sterility, frequency of aberrant cells) associated with chromosome aberrations were positively correlated with duration of flight.

The authors state that the effects of both ground and flight storage were greater for A. thaliana than for C. capillaris because the A. capillaris seeds are longer lived. Comparison of the effects of space flight on a weakly active system (dry seeds) and an active system (growing plants) demonstrates that, all else being equal, the magnitude of the effects is greater in the active system. Cells of plants grown under

P312

flight conditions had twice the aberration frequency and higher death rates than those of plants grown on Earth from flight seeds. Decrease in mutations with flight time greater than 226 days for A. thaliana is explained by the fact that the majority of the genetically damaged plants died during the earlier part of the flights. The authors claim that the damage to the meristem of germs, and the consequences of this damage, in the 827-day flight cannot be attributed solely to the heavy component of radiation. Instead, they argue, there is evidence that exposure to weightlessness accelerates the aging process. As evidence for this they cite the virtually total loss of germination capacity of A. thaliana seeds after the longest exposure to space (while comparable storage on Earth was associated with a 73.12% germination rate) and the fact that the frequency of aberrant cells in Crepis capillaris after 827 days in space corresponds to the effects of storage on Earth for 7-8 years. They further postulate that the mechanism for accelerated aging in space involves decreases in the reparative capacity of cells.

Table 1: The Effects of Space Flight Factors on A. thaliana seeds, %

Length, days	Storage Condition	Germination rate	Plant Viability	Sterile seed buds	Sterile pods	Recessive mutants
49	Ground	91.03	69.28	6.55	8.51	10.19
	Flight	86.65*	60.56*	8.31**	12.05*	9.30
201	Ground	74.11	46.19	11.90	12.80	10.01
	Flight	93.91**	72.59**	7.84**	11.86	13.31**
226	Ground	94.09	60.69	8.85	17.86	3.78
	Flight	87.07**	53.33*	12.12**	14.82*	14.87**
408	Ground	67.59	24.55	19.36	23.77	7.81
	Flight	65.16	25.93	23.43**	26.32	7.66
827	Ground	73.12	48.68	7.37	7.37	2.98
	Flight	0.41**	0	--	--	--

\* difference between ground and flight conditions,  $p < 0.05$

\*\* difference between ground and flight conditions,  $p < 0.01$

Table 2: The effects of space flight factors on C. capillaris seeds

Length of storage, days	Germination rate, %		Aberration frequency	
	Ground	Flight	Ground	Flight
49	--	--	0.13	0.16
201	96.84	98.84	0.50	0.84
226	--	--	0.23	0.52
408	--	--	0.75	1.03
827	93.66	87.61	3.63	13.83

## BOTANY

P312

Table 3: The effects of space flight factors on the fertility and descendents of plants developing under space flight conditions

Condition	Sterile seed buds, %	Sterile fruit, %	Total Mutants, %
Control (ground)	45.03	6.98	12.29
Svetoblok apparatus (flight)	33.80	11.70	27.10
Fiton apparatus (flight)	46.18	19.59	28.00

## BOTANY

P313(8/86) Abilov ZK, Alekperov UK, Mashinskiy AL, Fadeyeva SI, Aliyev AA.  
**The morphological and functional state of the photosynthetic system of plant cells grown for varying periods under space flight conditions.**

In: Kovrov BG, Kordym VA, editors.

Mikroorganizmy v iskusstvennykh ekosistemakh.

**[Microorganisms in artificial ecosystems].**

Moscow: Nauka; 1985.

Pages 29-32.

See also Digest Issue 4: P181; Digest Issue 5: P221, P222.

Botany, Photosynthesis System, Cells

Peas, Orchids

Space Flight

**Abstract:** This study investigated the effects of space flights lasting 29 and 110 days on the morphological characteristics of the leaves of orchids (Epidendrum radicans) and pea (Pisum sativum) plants. Pigment composition and absorption and fluorescent spectra of the plant leaves were also studied. The plants were grown in space (flight not specified) in ionite nutrient soil under continuous illumination at a distance of 20 cm from the light source (intensity 9300 lx). Control plants were grown under analogous laboratory conditions. Morphological analysis revealed substantial differences between the chloroplasts of flight and control plants of both species. First, the stroma of flight plants were less densely saturated with ribosomal structures and lacked sharply differentiated zones containing chloroplast DNA. In contrast to the control plants, the flight specimens either lacked starch reserves or contained a small number of small grains. The most striking differences involved the intrachloroplast membrane system. Aside from organelles with normal membrane structure, the flight plants showed major disruptions of this structure, disintegration or destruction of the grana, disorientation or separation of the thylakoids of the stroma, thinning of the membrane comprising the grana stacks, and formation of electron-transparent bubbles. No changes were noted in the ultrastructures of the nuclei, mitochondria, dictyosomes or other cell organelles. Study of the spectral characteristics of untreated leaves of both types of plants and also of their homogenates, showed that in low temperature absorption spectra the fractions of chlorophyll b and short wave forms of chlorophyll a were lower for flight plants than for controls. At the same time, absorption was higher for flight plants in the long wave band. Peaks of the first derivative short wave spectrum showed that flight plants appeared to contain essentially the same forms of chlorophyll as the control plants. However, for both species the long wave peak occurred 1 nm higher for flight plants. Low temperature fluorescence spectra showed that flight plants has a somewhat higher long wave maximum than control plants, attributed by the authors to an increase in the long wave aggregated forms of chlorophyll for flight plants.

## CARDIOVASCULAR AND RESPIRATORY SYSTEMS

[See also: Adaptation: M87, Hematology: P318; Metabolism: M89;  
Neurophysiology: P341; Operational Medicine: P316]

### PAPERS:

P320(8/86)\* Tikhonov MA, Asyamolova NM.

**Physiological mechanisms limiting external resistance to respiration.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 45-49; 1986.

[14 references; 7 in English]

Cardiovascular and Respiratory Systems, Respiration; Neurophysiology,  
Neural Regulation  
Humans, Males  
Impeded Respiration

**Abstract:** Subjects in this experiment were 8 healthy males, aged 18-23. The experiment investigated the temporal characteristics of proprioceptive reflexes of the respiratory muscles in response to a sudden interruption of the flow of air. This interruption was created by means of a pneumatic barrier fitted on the end of a pneumotaxographic tube. Reflex latency was measured from the beginning of the interruption of the air stream to the appearance of an additional wave of the pressure curve of the mouthpiece, which reflects the occurrence of supplementary inspiratory or expiratory effort on the part of the respiratory muscles to overcome the sudden impediment to respiration. The temporal parameters of these reflexes were studied during respiration without external resistance and with nonelastic resistance created by inserting one of a number of tubes, 2 to 16 mm in diameter, in the respiratory tract in tandem with the pneumatographic tube and valve. Resistance level was defined as that pressure necessary to produce a constant air flow of  $90 \text{ l} \cdot \text{min}^{-1}$ . Measurements were made with the subjects at rest or during graded physical exercise on a bicycle ergometer. Physical loadings were combined with external resistance to respiration of 0 ( $R_0$ ; control condition) and with resistance in the range of 60-400 mm Hg (6.0-40.0 GPa) with  $V = 90 \text{ l/min}$  ( $R_{60} - R_{400}$ ). The pneumotaxograph produced a pneumotaxogram and a spirogram, while an electromanometer was used to record pressure in the oral cavity and the chest.

As respiratory resistance and concurrent physical loading increased, subjective sensations of discomfort increased rapidly, while physiological parameters of respiration changed only slightly. The authors emphasize that the subjective sensations created by this procedure are disproportionate to the actual physiological effects. This can be explained by the presence of a relatively powerful system directed at providing sufficient compensation in cardiorespiratory parameters. Since compensatory reactions to resistance to respiration occur in very short intervals, they argue that neural reflexes must play a key role. To find out more about this, the temporal characteristics of proprioceptive reflexes were studied during respiration with  $R_0$ ,  $R_{150}$ , and  $R_{250}$  while performing three 15-minute cycles of exercise of 100-150 W. With resistance of  $R_0$ , reflex time was 0.18 seconds; this did not change significantly during the 3 exercise cycles. At the higher resistance levels the reflex latency increased from cycle to cycle and at the end of

## CARDIOVASCULAR AND RESPIRATORY SYSTEMS

P320

the third cycle was 0.29 and 0.38 seconds, for  $R_{150}$  and  $R_{250}$ , respectively. The authors attribute this effect to fatigue of the respiratory musculature, which leads to a functional deficit in the proprioceptive system of respiratory regulation. In breathing against resistance, especially non-elastic resistance, the respiratory muscles are compelled to compensate for a resistance which does not stay constant throughout the respiratory cycle. To maintain normal dynamics of the rate and volume parameters of the cycle, the muscle compensations must be very flexible and must occur over very short periods of time; however, it is known that the rate of muscle contraction is inversely proportional to their loading. This was studied by comparing forced expiration with and without resistance. When forced expiration at  $R_{250}$  was compared with a situation without resistance, it was found that pressure (reflecting expiratory effort) increased by nearly a factor of 10, but nevertheless the maximum velocity of the air stream decreased by a factor of two, volume dropped somewhat, and time increased. On the basis of these results the authors conclude that the respiratory muscles are able to create the required respiratory volume to compensate for a given resistance, but cannot do this in the required period of time, since expiration occurs with diminished velocity. Thus, loading the respiratory muscles through external resistance decreases their speed of contraction. This accounts for the effects of the combination of respiratory resistance and physical exercise.

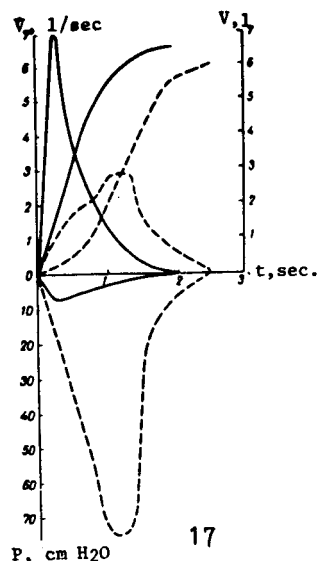
Figure Titles: Figure 1: Curves of nonelastic resistance studied as a function of volumetric velocity of a constant air flow

Figure 2: Changes in latency of proprioceptive reflexes of the respiratory muscles during breathing under external resistance while performing physical exercise

Figure 3: Changes in latency of proprioceptive reflexes during 3 cycles of physical loading of 100-150 W combined with respiration without external resistance, and with resistances of  $R_{150}$  and  $R_{250}$

Figure 4. The relationship among pressure, air flow, and volume during forced expiration

Solid lines are expiration without resistance; dotted lines are  $R_{250}$



## CARDIOVASCULAR AND RESPIRATORY SYSTEMS

P325(8/86)\* Degtyarev VA, Kormer AYa, Rogov VA, Tolpekin VYe, Tsyganov LP, Ragozin VN, Shcherbakov YeYu, Kirillova ZA.

**Interpretation of kinetocardiograms of the right heart.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 69-68; 1986.

[6 references; 1 in English]

Cardiovascular and Respiratory Systems, Kinetocardiogram, Right Heart  
Humans, Males; Patients, Myocardial Infarction  
Operational Medicine, Diagnosis

Abstract: Kinetocardiograms of the right heart were obtained for 20 healthy male subjects, aged 18-20, and 15 male patients, aged 46-62, diagnosed as suffering from acute myocardial infarction of the left ventricle. A piezo ceramic sensor identical to the one used on cosmonauts' left hearts on the "Salyut" stations was used to produce these profiles. The kinetocardiograms thus obtained were compared with records produced by ultrasonic Doppler echocardiograms for the healthy subjects, and direct sounding of the catheterized right heart for the patients. Analysis showed that the kinetocardiograms reflected the dynamics of contraction of the right heart. This method was recommended for further studies of cosmonauts and pilots.

Table and Figure Titles: Table: Duration of systolic phase and diastolic phase of the right heart

Figure: The source of kinetocardiogram features of the right heart as revealed by results of manometry of the heart and ultrasound Doppler echocardiography

## CARDIOVASCULAR AND RESPIRATORY SYSTEMS

P327(8/86)\* Demin AN, Galustyan MV, Belkaniya GS, Dartsmeliya VA.  
**Rheotacho-oscillographic recording of blood pressure in monkeys.**  
Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.  
20(3): 73-75; 1986.  
[3 references; none in English]

Cardiovascular and Respiratory Systems, Blood Pressure Measurement  
Monkeys  
Measurement Technique, Rheotacho-oscillography

**Abstract:** The authors of this paper propose a noninvasive technique for measuring the diastolic and systolic blood pressure of monkeys undergoing experimental treatment. A sphygmomanometer cuff is placed on the monkey's upper arm, thigh or calf, and smoothly inflated and deflated while a rheooscillogram is made of the vessels of the extremity.

**Figure title:** Figure 1: Diagram of system for measuring blood pressure using a rheotachoscillographic method through discrete or continuous measurement of the pressure in the pneumatic cuff

**Figure 2:** Rheotachyoscillogram of monkeys during discrete and continuous registration of pressure in a pneumatic cuff

**Figure 3:** Changes in diachrotic formation of rheooscillations during continuous decompression of the pneumatic cuff, registered during scrolling of the tape

**Figure 4:** Parallel registration of blood pressure directly and using the rheotachoscillographic method



## CARDIOVASCULAR AND RESPIRATORY SYSTEMS

P340(8/86) Saudlya AP, Belkina LM, Markovskaya GI, Shimkovich MV.  
**Cardiac contractility in animals undergoing long-term hypokinesia.**  
In: Zor'kin, editor. *Metabolicheskiye protsessy pri nekotorykh ekstremal'nykh sostoyaniyakh* [Metabolic processes during exposure to certain extreme factors]. See M89, this issue.  
Kishinev: Shtiintsa; 1985; 77-87.

Cardiovascular and Respiratory Systems, Contractility  
Rats  
Hypokinesia, Long-term; Psychology, Stress

**Abstract:** In the experiment described here Wistar rats were confined in an immobilization cage for 15, 30, 60 and 90 days. Rats were weighed at the end of each period rats and cardiac contractility of control and experimental animals was examined either while the heart was still in the body, or after the heart and papillary muscle had been isolated. In the first case, animals were anesthetized and respiration was artificially induced while intraventricular pressure was recorded. The resulting pressure curves were used to calculate the following indices: maximum systolic, diastolic and developed blood pressure; level of functioning (the product of developed pressure and frequency of contraction per unit of weight of the left ventricle); and maximum speed of pressure rise and fall in the left ventricle, an indicator of myocardial contraction. After baseline values were recorded, electrical stimulation was used to gradually develop contraction rates ranging from 300 to 600 per minute. After a ten minute rest, maximum stress was placed on the heart by squeezing off the aorta for 30 seconds. The isolated heart was studied by removing the the right auricle and placing a latex ballon with constant volume in the cavity of the left ventricle. When the balloon was squeezed the ventricle underwent isovolumetric contractions. A contraction rate of 130 beats per minute was induced. The heart was perfused through the aorta with an oxygenated solution containing glucose. Pressure in the left ventricle was recorded and the indices listed above were computed. The anterior papillary muscle of the left ventricle was extracted from the isolated heart, placed in an aerated solution and stimulated with electric pulses 5 msec in duration and 20% above threshold in amplitude. The optimal loading under which the muscle was stretched to maximum length was determined by the maximum isotonic shortening caused by the solution.

Rats undergoing hypokinesia showed no weight gain, while control rats more than doubled their weight by the end of 90 days. The authors state that one reason for the cessation of overall growth is the occurrence of the stress syndrome, activation of the hypothalamus and pituitary systems, and increased formation of ACTH (an antagonist of somatotropin). In the authors' opinion, another reason for this stunting might be the cessation of coprophagy. Growth of the hearts of the experimental animals was slowed by only 31%, considerably less than the retardation of overall growth. The net result of this was a 44% relative enlargement of the hearts of the experimental animals. This tendency to cardiac enlargement is attributed by the authors partially to the stress syndrome and partially to tachycardia and hypertension. When the rats hearts were forced to beat at a high rate, there was virtually no distinction between the developed pressure and maximum rise and fall of pressure of the control and experimental animals. The parameter indicative of the work performed by a

## CARDIOVASCULAR AND RESPIRATORY SYSTEMS

P340

unit of the myocardia was 80% higher for the experimental animals than for the controls. When the heart was put under maximum stress by occlusion of the aorta, the hearts of the experimental animals beat substantially more slowly than those of the controls. The authors conclude that these results show no defects in cardiac contractility attributable to hypokinesia; when the heart is forced to beat very fast, the work performed by the hearts of experimental animals was greater than those of controls. The studies with the isolated hearts and latex balloons showed decreased maximum developed pressure and decreased rate of rise and fall in blood pressure for the animals which had undergone hypokinesia. The authors attribute this to the fact that the hearts of the control animals are bigger. When maximum developed pressure and rate of change of blood pressure are computed per unit heart weight for each group, the hearts of the experimental animals were found to be functioning at a higher level. Analysis of the parameters measured for isometric contraction of the papillary muscle showed that the force and speed of contraction and relaxation were decreased in animals exposed to hypokinesia on day 15, increased on day 30, and still further increased on day 60 relative to control animals. The authors suggest two possible reasons for this set of results. First, the smaller hearts of the experimental animals might consist of smaller myocytes, which contract more efficiently. Secondly, as ontogenetic growth progresses, ATP-ase activity of actomyosin decreases (ATP-ase determines the speed of cardiac muscle contraction).

Tables and Figures: Table 1. Changes over time in overall and heart weight of white rats during adaptation to hypokinesia

Table 2: Parameters of isotonic contraction of the papillary muscles of white rats undergoing hypokinesia

Table 3: Parameters of isometric contraction of the papillary muscles during adaptation to hypokinesia

Figure 1: Figure 1: Changes over time in developed pressure, work index, speed of contraction and relaxation of the left ventricle of the hearts of animals exposed to hypokinesia and control animals during induced high rates of contraction

Figure 2: Changes over time in developed pressure, speed of contraction, heart rate, and work performed by the left ventricle of the heart after total occlusion of the aorta in control animals and animals adapted to hypokinesia

Figure 3: Changes over time in developed pressure, work performed, speed of contraction and speed of relaxation of the left ventricle of the isolated heart of control animals and animals subjected to hypokinesia during induced high frequency contractions

## CARDIOVASCULAR AND RESPIRATORY SYSTEMS

P331(8/86)\* Gansburgskiy AN, Potapov PP.

### **Morphometric analysis of the endothelium of the aorta and serum lipids in rats undergoing hypokinesia.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 82-83; 1986.

[9 references; 1 in English]

Cardiovascular and Respiratory Systems, Aorta Endothelium, Serum Lipids;  
Rats

Hypokinesia, Immobilization; Psychology, Stress

**Abstract:** In this study, 30 rats were maintained in an immobilization cage for periods of up to 30 days. One animal per day was sacrificed and studied. One control rat was sacrificed on days 4, 8, 12, 16, 20, 24 and 28. The aorta was removed, fixed and stained. The mean area of the endothelocytes, and their nuclei and cytoplasm, were measured for 175-200 cells per animal. The ratio of nucleus to plasma was also determined. In addition, the number of endothelial cells with karyopyknosis and with 2 nuclei were counted for a population of 8000-1000 cells per animal. For the biochemical portion of this study, 40 rats were maintained in immobilization cages and 7 served as a control; rats were sacrificed on days 7, 15, 21 and 30 of the experiment. The concentration of serum cholesterol and phospholipids was determined. No changes were noted in the morphological parameters for control animals. In the first week of hypokinesia, there was an increase in the area of the endothelium, attributable to increases in the size of both the nucleus and the cytoplasm. In the first few days a concurrent increase was observed in the number of cells with 2 nuclei. No destructive changes were observed. Toward the end of the second week of hypokinesia, the proportion of cells with karyopyknosis and 2 nuclei was close to the norm, the area of the nuclei was somewhat elevated, and the increase in cytoplasmic area (and of the endothelium as a whole) was up sharply. The ratio of nucleus to cytoplasm area decreased. Between days 21 and 30, there was another substantial increase in the area of cytoplasm, and between days 25 and 30 the ratio of nucleus to cytoplasm dropped again, demonstrating a decrease in the functional activity of the nuclei. In addition, there were noticeable destructive changes in the nuclei during this period and the percent of pyknotized nuclei reached a maximum on day 27. The authors state that such changes would lead to increased penetrability of the endothelium, persisting even after hypokinesia had terminated and making it easier for lipoproteins to permeate the vessel wall. Days 21 and 30 showed the highest levels of hyperlipemia while the level of phospholipids showed a tendency to decrease. The authors conclude that days 21 to 30 of hypokinesia are the most dangerous from the standpoint of vascular damage.

**Figures:** Figure 1: Changes over time in morphometric parameters of the aorta endothelium in rats subjected to hypokinesia

Figure 2: Concentration of cholesterol and phospholipids in blood serum of rats undergoing hypokinesia

COSMONAUT TRAINING: See Human Performance: M94  
CYTOLOGY: See Body Fluids: P348; Radiobiology: P357, P360  
ENDOCRINOLOGY: See Body Fluids: P348, M88; Radiobiology: BR8, BR9

#### ENZYMOLGY

(See also: Exobiology: P343; Gastrointestinal System: P344)

#### PAPERS:

P309(8/86) Smirnov KV, Ruvnova LG, Medkova IL, Struchkova TYa, Tolmacheva MYa.

**The functional state of the pancreas during long-term bedrest.**

Fiziologiya Cheloveka.

12(3): 499-502; 1986.

[9 references; 3 in English]

Enzymology, Pancreas

Humans, Males

Hypokinesia, Head-down Tilt, Bed rest

Abstract: In this experiment, 6 healthy men (aged 32 to 46) were subjected to a 120-day period of bed rest with head-down tilt of  $-4.5^{\circ}$ . The exocrine function of the pancreas was evaluated by measuring the activity of pancreatic enzymes, amylase, lipase and trypsin in duodenal juice obtained on an empty stomach, and in blood serum and urine. Measurements are cited for a baseline period, days 20, 28, 29, 68, 70, 89, 95, 110, and 112 of the bed rest treatment and for days 7, 10 and 25 of a post-treatment recovery period. The functional state of the pancreas was determined through ultrasound scanning, performed in the morning on an empty stomach, 5 and 14 days and 6 months after termination of the bedrest. Amylase activity had decreased significantly in duodenal juice on day 89 of bed rest, and by day 110 it had returned to normal. Amylase activity in blood increased gradually and was significantly above baseline by day 95 of hypokinesia. Three subjects showed pronounced hyperamylasemia. Increased concentrations of amylase in the blood continued through the recovery period. Trypsin activity in duodenal juice was diminished on days 68, 89 and 112 of hypokinesia, but differed significantly from baseline only on day 89. In all but one of the subjects trypsin in duodenal juice reached or exceeded baseline level during the recovery period. There was a slight tendency for trypsin to increase in the blood during the treatment. Pancreatic lipase in the duodenal juice was decreased significantly at all measurement points during the treatment. Its minimum level was 5.2% of baseline, attained on day 89. On day 10 of the recovery period lipase activity in duodenal juice was still only 5.6% of baseline. Of the 6 subjects, 4 showed increased pancreatic lipase activity during bed rest, for 1 subject throughout the treatment and for 3 during the latter portion of the period. Pancreatic lipase activity in urine differed significantly from baseline only on day 70, when it was increased. Ultrasound scanning on day 5 of the recovery period revealed structural changes in the pancreas in all subjects, as indicated by decreased acoustic density, which is a sign of edema of the parenchyma. In addition, in 2 subjects the head of the pancreas was found to be enlarged; in 3 subjects the tail was enlarged and in 1 subject both ends were enlarged. A tendency toward normalization of the acoustic parameters of the pancreas was noted in all subjects on day 14 of the recovery period, and by month 6 no effects of the treatment

## ENZYMOLOGY

P309

remained. The authors conclude that these results (changes in the enzyme spectrum of the duodenum, increased levels of enzymes in the blood, and edema) demonstrate that long-term hypokinesia with head-down tilt significantly affects the functioning of the pancreas. They describe these effects as a compensatory form of pancreatic insufficiency. The major reasons for the changes observed are fluid shifts to the upper portions of the body, microcirculatory changes in the organs in the abdominal cavity, and the set of metabolic shifts indirectly linked to the exocrine function of the pancreas.

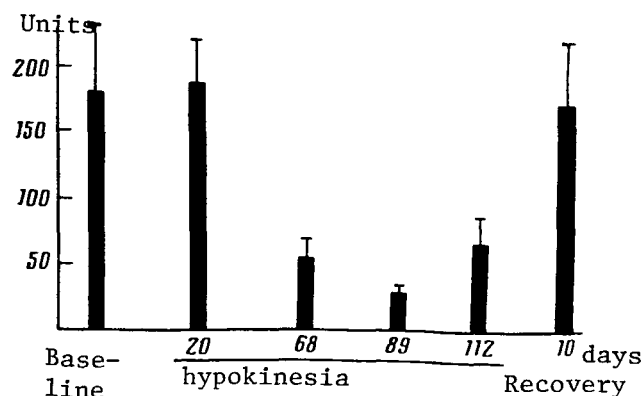
Table 1: Activity of pancreatic lipase in duodenal juice during and after 120 period of hypokinesia with head-down tilt (n=5)

Time	Pancreatic lipase (umole/m/l)	Significance of difference from baseline
Baseline	63,900	
Hypokinesia		
Day 20	45,300	$p > 0.1$
Day 68	36,500	$p > 0.1$
Day 89	3,300	$p < 0.001$
Day 110	6,900	$p < 0.001$
Recovery		
Day 10	3,600	$p > 0.1$ [sic]

Table 2: Activity of pancreatic lipase in blood serum

Figure 1: Activity of amylase in duodenal juice and blood serum during a 120-day period of hypokinesia with head-down tilt

Figure 2: Activity of trypsin in duodenal juice during a 120-day period of hypokinesia with head-down tilt



## EQUIPMENT AND INSTRUMENTATION

### PAPER:

P328(8/86)\* Gritsuk AI, Danilova IG.

#### **A cage for simulating long-term hypokinesia in rats.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 75-78; 1986.

[13 references; none in English]

Equipment and Instrumentation, Hypokinesia, Immobilization Cage,  
Rats

Metabolism; Musculoskeletal Systems. Tissue Respiration, Oxidative  
Phosphorylation

**Abstract:** This paper is devoted to the description of an immobilization cage for simulating the effects of long-term weightlessness in rats. The authors set the following criteria for the cage: 1) It must allow the animal to maintain its normal position and to groom various parts of its body, thus decreasing the general level of stress associated with hypokinesia. 2) There must be a mechanism for varying the exact size of the cage to control the severity of the treatment and to accommodate animals of different sizes; 3) It must be inexpensive and easy to construct and use (ventilation, delivery of food and water, sanitation), and allow for long-term observation of the general state and appearance of the animals; 4) It must be constructed from materials which are hygienic, mechanically strong, chemically inert and have good insulating properties. To meet these criteria, an 8-compartment cage with dimensions of 290 X 180 X 65 mm was constructed out of wood. The size of the individual compartments allowed the animals to assume a natural position and to groom some parts of their bodies. However, their movement could be further restricted through use of a wooden insert. The cages are placed on a tray made of aluminum or plastic filled with wood shavings, facilitating insulation and cleaning. If the study requires collection of wastes from individual animals, this tray can be replaced by a compartmentalized one. The cages are fitted with individual feeding troughs and water bottles. The cages were used in a study of the effect of 140 days of hypokinesia on tissue respiration and oxidative phosphorylation of muscle tissues. The data obtained, including evidence of hyperlipemia, and rapid consumption of lipids by muscle tissue, reinforces current theories of metabolic disturbance in hypokinesia, thus indirectly confirming the adequacy of the cage-based simulation.

**Table and Figure Titles:** Table 1: Effects of long-term hypokinesia on tissue respiration in sections of myocardia and calf muscles of rats

Table 2: The effects of long-term hypokinesia on the concentration of substrates in the blood

Figure 1. Three views of the rat cage developed.

## EXOBIOLOGY

### PAPERS:

P342(8/86) Boychenko, YeA.

**The participation of iron-sulphur proteins in the evolution of carbon dioxide reductases.**

Zhurnal Evolyutsionnoy Biokhimii i Fiziologii.

22(3): 221-225; 1986.

[15 references; 7 in English]

Affiliation: V.I. Vernadskiy Institute of Geochemistry and Analytic Chemistry, USSR Academy of Sciences, Moscow

Exobiology, Evolution, Aerobiosis

Carbon Dioxide Reductases

Iron-sulphur Proteins

**Abstract:** Iron-sulphur proteins are components of many oxidoreductases which participate in the critical processes of oxidation and reduction within organisms. In the course of evolution of aerobiosis, various changes occurred in the composition and catalytic activity of these proteins. With regard to the reductases involved in the evolution of carbon dioxide assimilation reactions, these changes moved in the direction of increased molecular weight and concentration of lipids in the molecules. In the evolution of the assimilation of carbon dioxide, changes in the donor-acceptor interaction of metal enzymes is related to the growth of hydrophobic conditions in the chloroplast. Lipids participated in the inclusion of a second metal, manganese, in the active centers of the iron-containing reductase, increasing their potential for reduction. As evolution proceeded, the ratio of iron to manganese decreased. The presence of manganese compounds was important in the oxidizing reactions which are concurrent with the reduction of carbon dioxide. By virtue of the formation of lipid-metal complexes, lipids became not only structural components of membranes, but participants in the most important enzymatic reactions. The concentration of the bonds between certain metals and various groups of lipids increased in the membranes of the organelles in comparison with whole cells. This enabled electron transport reactions within a greater range of oxidation-reduction potential with a large number of electron donors and acceptors. The increase in the number of lipophilic metal compounds, dissolved in acetone, was accompanied by an increase in their potential for the catalytic assimilation of carbon dioxide, as well as an increase in the level of light at which they could occur in the aerobic biosphere. The association between lipid content, reducing capacity of reductase and optimal light was demonstrated by measuring the amount of hydroxamic acid produced by carbon dioxide reductases derived from clover protein, which had been reprecipitated once, twice, or three times with 75% acetone and exposed to varying levels of light. A solution of hydrosulphite and sodium bicarbonate was used as the electron donor. Results are shown in Table 3.

# EXO BIOLOGY

P342

Table 1: Participation of iron-sulphur proteins in reduction reactions.

Iron-sulphur proteins and the reductases containing them (potential $E_0'$ V)	Participation in reactions	
	Means of carbo- hydrate reduction	Oxidation-reduction systems
Ferredoxins-- iron containing water soluble proteins in cells ( $E_0'$ up to -0.2V)	Reductive carboxylation: Nicotinamides $CO_2 + \text{acylCoA} \rightarrow$ $\text{ketoacid} + \text{CoA}$	
Hydrogenases--iron-flavoproteins, partially bound with membranes ( $E_0'$ up to +0.1 V)	Reduction: $CO_2 +$ $+4H_2 + O_2 \rightarrow$ $(CH_2O) + 3H_2O$	Flavinnucleotides
Redutases $CO_2$ -- iron-lipo-flavoproteins bound with membranes ( $E_0'$ up to +0.5 V)	Photoreduction: $CO_2 +$ $R + H_2O \rightarrow (CH_2O) + RO_2$	Carotinoids
Iron-sulphur proteins -- in electron-transport systems of chloroplast membranes ( $E_0'$ up to +0.8 V)	Photosynthesis: $CO_2 +$ $2H_2O \rightarrow (CH_2O) +$ $H_2O + O_2$	Chlorophylls

Table 2. Changes in iron-sulphur proteins in the course of evolution of aerobiosis

Iron-sulphur proteins and the reductases containing them (mol. wt.)	Changes in composition	
	Lipid content (% wt.)	Ratio of iron to manganese
Ferredoxins -- from anaerobic bacteria (6000 - 9630)	0	Manganese not found
Hydrogenases -- from various algae (127000 - 215000)	2.4 - 10.4	10.1 - 16.1
$CO_2$ Reductases -- from leaves of flowering plants (323000 - 426000)	29.8 - 32.5	4.3 - 8.6
$CO_2$ Reductases -- from isolated chloroplasts (506000 - 769000)	38.1 - 44.9	1.5 - 2.6



# EXO BIOLOGY

P342

Table 3. Activity of CO<sub>2</sub> reductases under varying levels of illumination

CO <sub>2</sub> reductases (lipid content, % wt) atom/hr)	Optimum Illumination (lux)	CO <sub>2</sub> reduction (muM/kg of Fe
CO <sub>2</sub> reductase - after 3 reprecipitations (26.5 - 29.8)	125	25.3 - 27.4
CO <sub>2</sub> reductase - after 2 precipitations (31.1 - 32.5)	250	50.1 - 78.9
CO <sub>2</sub> reductase - after 1 precipitation (34.7 - 39.3)	500	80.0 - 88.7
CO <sub>2</sub> reductase - unpurified (44.9 - 46.8)	1000	77.8 - 114.5

## EXOBIOLOGY

P343(8/86) Karasev VA, Stefanov VYe.

**Recombination and selection of active duplicated structure as a possible path of prebiological evolution of enzymes.**

Zhurnal evolyutsionnoy biokhimii i fiziologii.

22(3):226-232; 1986.

[15 references; 3 in English]

Affiliation; Department of Molecular Biotechnology; Lensoviet

Technological Institute, Leningrad

Exobiology

Enzymes

Evolution, Prebiological

**Abstract:** This paper uses the conception of a system of conjugated ionic hydrogen bonds and a theoretical model of elementary open catalytic systems (EOCS) to derive possible pathways of the evolution of enzymes. On the basis of their analysis, the authors argue that the recombination and selection of the most catalytically active duplicated EOCS which utilized hydrogen bond conjugation as a means of energy transfer would favor development of a system having maximum symmetry of supramolecular structure, with components demonstrating maximum chirality. It is hypothesized that this means of generating EOCS variants would be maintained throughout the course of prebiological evolution, and would be inherited by biological systems.

**Table and Figure:** Table: Groups of atoms occurring in biological molecules

**Figure:** Model of the catalytic activity of a dimeric enzyme

## EXO BIOLOGY

P347(8/86) Imshenetskiy AA, Lysenko SV, Petrukhina TYu, Sizova TP.  
**On the taxonomic classification of microorganisms isolated from the stratosphere and mesosphere.**

Mikrobiologiya.

55(1): 113-115; 1986.

[20 references; 12 in English]

Affiliation: Institute of Microbiology, USSR Academy of Sciences. Moscow;  
 M.V. Lomonosov Moscow State University

Exobiology, Life in Space

Microbiology, Conidia, Fungi, Bacteria

Stratosphere and Mesosphere

**Abstract:** Using a meteorological rocket, particles in the upper atmosphere (51-85) were collected in a cylindrical collector to which a silicon film had been applied. On the basis of radar data and the flight trajectory, it was possible to determine the altitude at which the microbial cells had been obtained. The samples collected were grown on appropriate media and identified using standard techniques. The microorganisms identified are listed in the table below. The predominant organisms collected were spores of fungi and pigmented conidia. (Pigmentation would tend to increase the resistance of the organisms to solar radiation). There were fewer types of bacteria than fungi. The strains of fungi identified did not show any significant differences from typical strains. The strains of micrococci, however, showed some differences from typical strains (e.g. failure to hydrolyze gelatin).

**Table: Species composition of microorganisms identified in the upper layers of the atmosphere.**

Microorganism	Altitude at which microorganisms identi- fied, km	Number of colonies identified
<u>M.luteus</u> 56	52-61	1
<u>M. roseus</u> 57	52-79	2
<u>B. subtilis</u> 51	52-79	2
<u>B.subtilis</u> 52	52-79	1
<u>Mucor circinelloides</u> 58	52-60	2
<u>Scopulariopsis brevicaulis</u> 56	62.5	1
<u>A. niger</u> 50	51-70	4
<u>Penicillium variabile</u> 64	63-84	2
<u>P. chrysogenum</u> 53	52-79	2
<u>P. chrysogenum</u> 54	52-81	4
<u>P. chrysogenum</u> 66	69	1
<u>P. eben-biatrianum</u>	66	2
<u>P. terrestre</u> 63	69	2
<u>P. verrucosum var. cyclorium</u> 43	70-81	2
<u>Penicillium</u> sp. 42	56-79	3
<u>Penicillium</u> sp. 47	52-70	3
<u>Cladosporium cladosporoides</u> 44	66-81	3

## EXO BIOLOGY

### MONOGRAPH:

M92(8/86) Belenkina NS.

Arena biologicheskoy evolyutsii. Sbornik. (Novoye v zhizni, nauke, tekhnike. Ser. "Biologiya")

[The arena of biological evolution. A collection. (Innovations in life, science and technology. "Biology" Series)]

Moscow: Znaniye; 1986.

[64 pages]

**Key Words:** Exobiology, Biospherics, Genetics, Evolution of Life

**Annotation:** This brochure discusses the beginning of life on Earth as a natural stage in the evolution of the Universe. It covers the tenets of Oparin's theory and alternative hypotheses, as well as problems of the origin of the genetic mechanism of heredity, the formation of chiral purity in the biosphere, and man's conquest of space (as a stage in the process of evolution of terrestrial life), and also the organizational principles of evolution and the mechanisms governing the interaction of subsystems within various open systems.

### CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

K.L. Gladilin. The problem of the origin of life (3)

S.I. Gleizer, K.B. Serebrovskaya. How did the genetic mechanism of heredity arise? (16)

V.I. Gol'danskiy. The beginning of life from the standpoint of physics (22)

O.G. Gazenko, I.P. Parfenov. The arena of biological evolution (36)

G.I. Ruzavin. Synergy, evolution and matter and locomotion ??(47)

References (63)

## GASTROINTESTINAL SYSTEM

(See also: Radiobiology: P356)

### PAPERS:

P344(8/86) Smirnov KV.

**The effects of microgravity on the digestive system [Literally: On the role of the gravitational factor in production of changes in the digestive system.**

Fiziologicheskiy Zhurnal SSSR imeni I.M. Sechenova.

LXXII(4): 484-489; 1986.

[13 references; none in English]

Gastrointestinal System, Enzymology, Proteolytic Enzymes

Rats

Space Flight, "Cosmos-782," "-936," "-1129," Artificial Gravity

Abstract: The functional state of the digestive system of rats was studied in experiments using the "Cosmos-782," "Cosmos-936," and "Cosmos-1129" biosatellites. Each of the three flights involved 3 groups of rats: an experimental group exposed to space flight for 19.5 days (Group I), a synchronous control (Group II), and a vivarous control (Group III). Certain animals in each group were sacrificed 5-11 hours after return to Earth, while others were sacrificed 24 days after landing. In the experiment using "Cosmos-1129," animals were also sacrificed 6 days postflight. In the "Cosmos-936" experiment, an additional group of animals was subjected to artificial gravity in space by means of centrifugation; a synchronous control group was also exposed to continually varying gravitational force by centrifugation on the ground. The experimenters investigated changes in proteolytic, carbohydrase and lipolytic enzyme complexes as revealed in enzyme activity in homogenates of the mucous membranes of the stomach and intestine, and the pancreatic tissue. Pepsin activity was measured in the mucous membrane of the stomach; the level of trypsinogen and amylase activity was determined in the pancreatic tissue; and invertase, dipeptase, pancreatic lipase and intestinal monoglyceride lipase activity was measured in homegenates and intact surfaces of the intestine.

Changes attributable to experimental conditions were observed in pepsin activity in homogenates of mucous membranes of the stomach. Statistically significant increases in the activity of proteolytic enzymes, trypsin and its zymogen trypsinogen, were observed in the pancreatic tissue of the flight group animals and, to a lesser extent, in rats in the synchronous group directly after landing. Centrifugation normalized trypsinogen levels in the flight and synchronous groups. Immediately after space flight, activity of dipeptidase was elevated in homegenates and, to a lesser extent, in intact tissue of the small intestine. On day 6 postflight, there was a tendency for activity to decrease. On day 25 postflight, a further drop was noted. Changes occurring in the synchronous group depended on whether the proximal or distal end of the intestine was considered. Artificial gravity did not exert a normalizing effect on the dipeptidase activity of the small intestine. Space flight, and to a lesser extent synchronous treatment, was associated with a decrease in amylase activity in pancreatic tissue. Centrifugation led to a further decrease in this activity. Invertase activity was increased post flight in both homogenates and intact intestinal tissue. A smaller increase was also noted in intestinal homogenate of the synchronous group. On day 25 postflight, invertase

# GASTROINTESTINAL SYSTEM

P344

activity had decreased in intestinal tissue of both the flight and the synchronous groups. Lipase activity in the pancreas increased postflight for the experimental and, to a lesser extent, synchronous groups. By day 25 postflight these levels had normalized. Flight was associated with a sharp decrease in lipolytic activity in the proximal section of the small intestine and significant increase in the distal portion. Artificial gravity had no effect on the activity of lipolytic enzymes. The authors conclude that all components of the proteolytic enzyme chain are mobilized as a stress reaction to space flight conditions. Because space flight is associated with a decrease in the activity of pancreatic amylase and a compensatory increase in intestinal invertase, they conclude that the role of membrane hydrolysis of carbohydrates increases under space flight conditions. Since, on the whole, effects were more marked for the space flight than for the synchronous groups, and in some cases artificial gravity neutralized the effects of space flight, the authors attribute at least some of these effects to microgravity and recommend artificial gravity as a countermeasure.

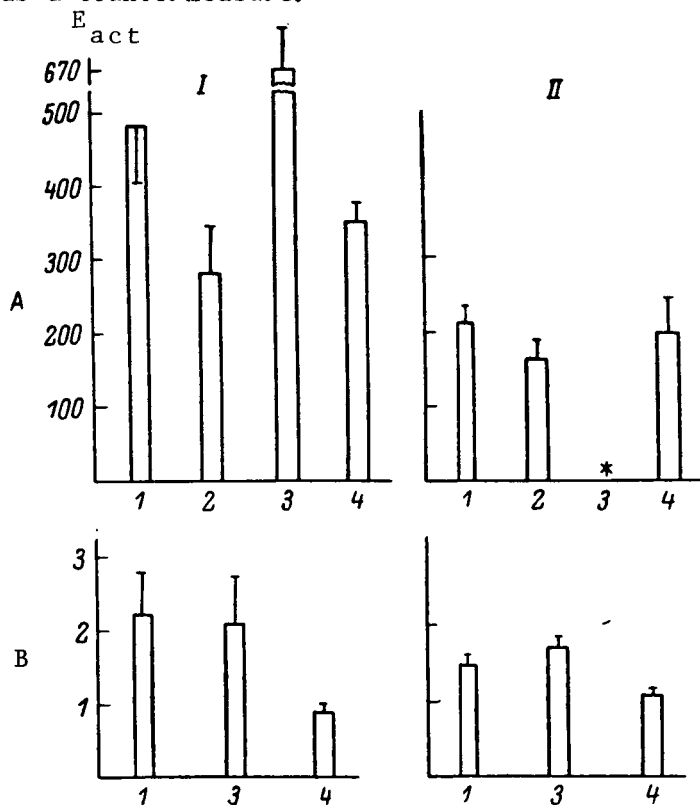


Figure 1. Proteolytic activity in the stomach and pancreas in biosatellite experiments. A -- Trypsinogen; B -- pepsin; 1 -- weightlessness; 2 -- weightlessness + centrifugation; 3 -- synchronous; 4 -- control. I -- first few hours postflight; II -- day 25 postflight; \* -- not measured;  $E_{act}$  -- enzyme activity (in units).

P344

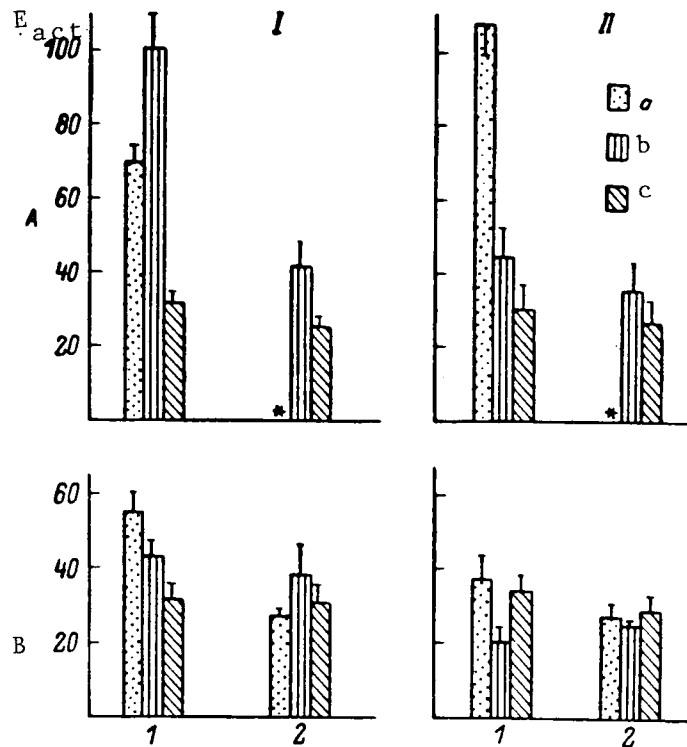


Figure 2: Dipeptidase activity in the small intestines of rats in biosatellite experiments. A -- first few hours postflight; B -- day 25 postflight 1 -- intact mucous membrane of the small intestine; II -- homogenate of intestinal mucous (membrane); 1 -- proximal; 2 -- distal portion of the small intestine; a -- flight; b -- synchronous; c -- control; \* -- not measured;  $E_{act}$  -- enzyme activity (in units).

P344

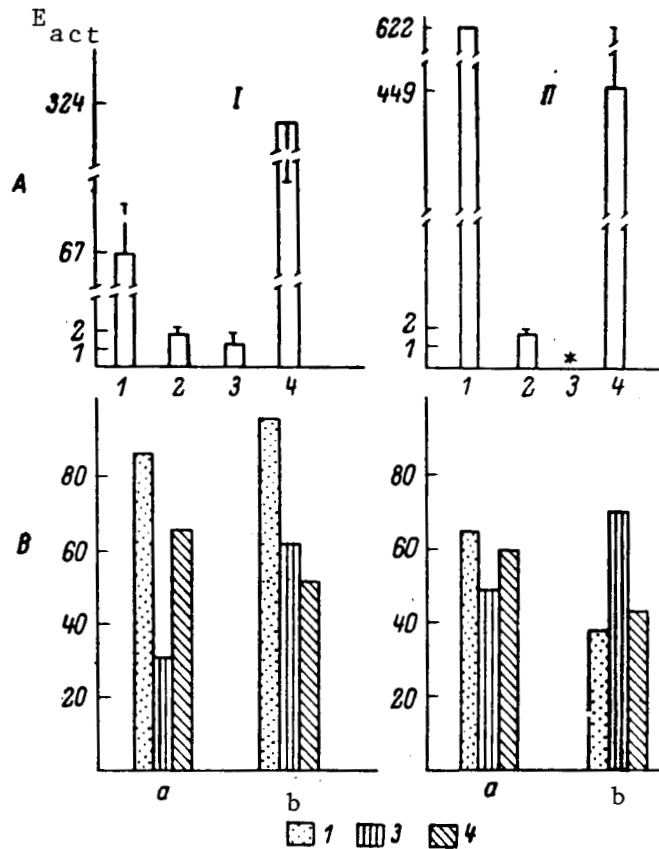


Figure 3: Carbohydrase activity of the pancreas and small intestine of rats in biosatellite experiments. A -- pancreatic amylase B -- invertase; I -- immediately postflight; II -- day 25 postflight; 1 -- flight; 2 -- weightlessness + centrifugation; 3 -- synchronous; 4 -- control; a -- proximal; b -- distal portion of the small intestine; \* -- not measured; E<sub>act</sub> -- enzyme activity (in scaled units).



## GENETICS

(See also: Botany: P312; Exobiology: M92; Radiobiology: P359, P360; BR9)  
**PAPERS:**

P315(8/86) Bobkova NN.

**Frequency of sister chromatid exchange in blood cells during long-term hypokinesia.**

Fiziologiya Cheloveka.

12(3): 503-505; 1986.

[25 references; 12 in English]

Genetics, Sister Chromatid Exchange, Hematology, Leukocytes  
Humans, Males

Hypokinesia, Head-down Tilt, Long-term; Countermeasures, Exercise,  
Isometric

**Abstract:** Subjects in this experiment were 7 males (sex not stated, inferred from abbreviations of names) who underwent a 120-day period of hypokinesia with head-down tilt ( $-5^{\circ}$ ). Of these, 3 (controls) were given no countermeasures; the remaining 4 participated in a daily 1-hour period of a specially developed isometric exercise program throughout the hypokinesia period. Blood was taken from all subjects before and 1 week after the hypokinesia treatment. The blood sample was cultured for a short time in a nutritive medium, seeded, and sister chromatid exchange induced by introducing phytohemagglutinin Difco "P", 5-bromodesoxyuridine, 28 - 30 hours before fixing the cells. The cell culture was fixed in hour 96, stained and processed. A total of 210 metaphase cells were examined before the beginning of the treatment. The number of sister chromatid exchanges in this baseline period varied between 5.12 and 9.56 per cell. After termination of the hypokinesia, 210 cells were again investigated. The frequency of exchanges ranged from 6.42 to 10.61 per cell. Increases were found in all individuals in the control group and 3 of the 4 in the isometric exercise group. However, the difference was statistically significant for only the former group.

**Table:** Frequency of sister chromatid exchanges in the blood of subjects before and after a 120-day period of hypokinesia with head-down tilt

## GENETICS

P329(8/86)\* Chabala LI.

### **Functional and structural transformation of chromosomes in various proliferating hemopoietic cells in the bone marrow of white rats.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 78-80; 1986.

[14 references; 8 in English]

Genetics, Chromosome Transformation; Hematology, Hemopoietic Cells, Bone Marrow

Rats

Splenectomy, Hypoxia

**Abstract:** The quantity, morphology, and dimensions of the chromosome in bone marrow and peripheral blood cells, as well as the mitotic activity and morphology of bone marrow cells, were studied in a total of 41 male white rats. The rats were divided into three groups: control animals; animals which had had their spleens removed 5 days previously; and animals which had been subjected to hypoxia (9000 m altitude equivalent) in a barochamber for 6 hours a day over 6 days. A karyotype was constructed of 79 typical metaphase plates (63 from bone marrow and 16 from peripheral blood) of the control group. The chromosomes (20 pairs of autosomes and XY sex chromosomes) were divided into 7 groups in descending order of size, with due regard for shape. Some polymorphism was noted in the three smallest pairs of autosomes (18, 19 and 20), but this did not manifest itself at the level of population or tissue. Three types of chromosomal structures were identified: I (pairs 18 and 19 acrocentric; pair 20 metacentric); II (pair 18 acrocentric; pairs 19 and 20 metacentric) and III (pairs 18, 19 and 20 metacentric). The bone marrow of control rats contained the greatest number of cells (44%) with Type II organization and the fewest (20%) with Type I. Peripheral blood showed only Type II structure. Type II is described as characteristic of the lymphocytic series. In rats which had had their spleens removed, the number of megakaryocytes in marrow had increased by a factor of 4.7 in comparison with control animals. In addition, the mitotic activity of the cells of this group had increased by a factor of 1.5 and the number of metaphases with Type I chromosome structure had increased by a factor of 3.7. The increase in the number of megakaryocytes and thus of metaphases with Type I chromosomal organization demonstrates that this type is characteristic of the hemopoietic megakaryocyte series in rats, the distinguishing feature of which is that chromosome pairs 18 and 19 are acrocentric, while pair 20 is metacentric. The rats exposed to hypoxia exhibited an increase in mitotic activity in the marrow by a factor of 1.9 compared to control level, and an increase by a factor of 2.1 of the erythroid series. The number of metaphases with Type III organization increased by a factor of 1.9, indicating that Type III corresponds to the erythrocytic of cells and is characterized by the fact that chromosome pairs 18, 19 and 20 are metacentric.

**Figure:** Type I, Type II and Type III structural organizations of chromosomes in the bone marrow of white rats in the control group

## GROUP DYNAMICS

### PAPER:

P345(8/86) Tsukanova YeV.

**Experimental investigation of impeded communication under conditions of time pressure. Part II. Types of creative personal communication arising during interaction in the presence of extreme factors.**

In: Novyye issledovaniya v psikhologii. [New research in psychology].

Moscow: Pedagogika; 1985. pp. 52-59.

Affiliation: N.V. Gogol' State Pedagogic Institute, Nezhin??.

Group Dynamics, Communication

Humans, Individual Differences, Extroversion, Neurosis

Extreme Conditions, Time Pressure

**Abstract:** In this study, groups of two subjects ("dyads") were asked to perform a difficult problem solving task involving a maze. Certain dyads were given unlimited time to complete the task, while others were placed under time pressure. The time pressure condition was considered a model of extreme conditions, while the other condition was referred to as optimal. All communications between members of the dyad were recorded and served as experimental material. The author hypothesized that communication in the time pressure condition would be more accurate and innovative (here, called "creative"), because of the premium placed on effective communication. On the basis of the results, the author concludes that this is the case. In particular, increased use of nonverbal and paralinguistic (e.g., intonation) communication, both alone, and as redundant support for verbal communication was noted under the time pressure condition. Subjects composing the dyads were selected for extreme values on either a scale of extroversion-introversion or high-low neuroticism, accompanied by moderate values on the other scale. It was found that non-neurotic subjects used more innovative means of communication under time pressure than neurotic subjects; no effect attributable to extroversion-introversion was observed. Although this is not stated directly, there was apparently also no effect of whether members of the dyad had similar or opposite scaled scores on either of these two dimensions.

## HABITABILITY AND ENVIRONMENT EFFECTS

(See also: Immunology: P349)

### PAPERS:

P334(8/86)\* Yasnetsov VV, Chukayev VV, Karsanova SK, Polkov VL.

**On the protective effects of endogenous morphine-like substances on acute hypoxia in mice.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 87-88; 1986.

[13 references; 4 in English]

Habitability and Environment Effects, Hypoxia

Mice

Countermeasures, Morphine-like Substances, Agonists and Antagonists

**Abstract:** In the experiment described here, outbred white male mice were exposed to acute hypoxia in a barochamber, the conditions of which were equivalent to an ascent to an altitude of 10,500 - 10,700 m at a rate of 30 m/sec. The objective was to determine how long the rats survived under these conditions. Before exposure to hypoxia, subgroups of the animals were injected peritonally with doses of various morphine-like substances, two specific antagonists of opiates, naloxone hydrochloride (a pure antagonist), and nalorphine hydrochloride (an agonist-antagonist), and two narcotic analgesics, morphine (a pure agonist of opiate receptors) and pentazocine hydrochloride (having weak antagonist properties). Drugs were administered at intervals of 5-10 minutes for naloxone or 15-20 minutes for the other three drugs before the mice were placed in the barochamber. Control animals were injected with a placebo. Morphine in a dose of 10 mg/kg and pentazocine in a dose of 25 mg/kg increased survival time. Lesser doses (1 and 10 mg/kg) of pentazocine tended to decrease this parameter, which the authors attribute to antagonistic properties of the drug. The antagonist drugs naloxone and nalorphine (at 1 mg/kg) shortened the time the animals lived in acute hypoxia, and increased the number which died during the ascent. When the dosage of nalorphine was increased to 5-10 mg/kg the life shortening effect was decreased; this was attributed by the author to nalorphine's morphine like properties. These results are interpreted as suggesting that endogenous morphine-like substances have a protective effect on animals exposed to acute hypoxia.

Table: Effect of drugs on the length of time mice survive hypobaric hypoxia

## HEMATOLOGY

(See also: Genetics: P315, P329; Radiobiology: P356, P358)

### PAPERS:

P318(8/86)\* Bugrov SA, Kiselev RK, Beleda RV, Plakhatnyuk VI, Artamonov NN, Ivanchikov AP, Tsyganok VA.

#### **Blood lipids and incidence of hyperlipemia in flight crews.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 39-43; 1986.

[20 references; 7 in English]

Hematology, Blood Lipids, Hyperlipemia  
Humans, Flight Crews, Cardiovascular Disorders  
Operational Medicine, Diagnosis

**Abstract:** In this experiment, the authors measured chloresterol and triglyceride concentrations in the blood serum of 2186 members of flight crews. Blood was taken in the morning on an empty stomach. Age (ages 20-49 at 5-year intervals) norms were established on the basis of concentrations of these substances in the blood of more than 1500 subjects who were either flight certified, or not certified for reasons other than cardiovascular disease. Norms established were compared with those of other authors. Using these norms, a linear regression was derived relating age, height and body weight to normal values of serum chloresterol and triglycerides. In the healthy population, lipid levels never exceeded the standard by more than 10%. Among those with cardiovascular disorders associated with arteriosclerosis, concentrations of chloresterol and triglycerides always exceeded the norms by more than 10%. On the basis of this data, it was proposed to diagnose hyperlipemia in anyone with chloresterol or triglyceride levels greater than 10% above the recommended value for his age group. Examination of all members of the flight crew from this standpoint indicated rather high levels of hyperlipemia. (See table 3.) The authors recommend this diagnostic indicator for use in early diagnosis and prescription of countermeasures in flight crews.

Table 1: Physiological norms for blood lipids among healthy members of flight crews of different ages

Blood Lipid	Age					
	20-24	25-29	30-34	35-39	40-44	45-49
Chloresterol, mmol/l	4.59	4.95	5.29	5.39	5.78	6.06
Triglycerides, mmol/l	1.45	1.55	1.58	1.76	1.88	1.96

Note: original table cites other statistics in addition to mean.

Table 2: Concentration of blood lipids in healthy members of flight crews compared with published data

## HEMATOLOGY

P318

Table 3: Incidence of hyperlipemia (in %) in members of flight crews  
(Numbers in parentheses refer to number of subjects.)

Age Group	Chlorestero1	Triglycerides
20-24	28.9 (207)	32.4 (111)
25-29	31.7 (408)	32.1 (244)
30-34	35.8 (520)	40.8 (281)
35-39	33.4 (577)	48.0 (281)
40-44	35.6 (233)	46.4 (153)
45-49	33.2 (241)	43.6 (195)

## HEMATOLOGY

P321(8/86)\* Goncharov IB, Ivanov AP, Davydkin AF, Kudryashova ZhM.

**The effect of hemodialysis on the rheological properties of blood during a 7-day period of hypokinesia with head-down tilt and in in vitro studies.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 50-53; 1986.

[13 references; 4 in English]

Hematology, Blood, Hemorheology

Humans, Males

Hemodialysis, Hypokinesia, Head-down Tilt

**Abstract:** Nine healthy males were subjected to a 7-day period of hypokinesia with head-down tilt of  $-8^{\circ}$ . On the seventh day, vein-to-vein blood dialysis was performed using activated charcoal (SKN-2M) as a filter. Blood for the study was drawn in the baseline period, and twice on day 7 of hypokinesia, once before and once after hemodialysis. Blood parameters measured included viscosity, yield point, erythrocyte aggregation, hematocrit, and concentration of hemoglobin. In addition, intraocular pressure and pressure in the central retinal artery, and diameters of the retinal artery and vein were measured. Hypokinesia with head-down tilt substantially affected most of the rheological parameters of the blood. Viscosity was significantly greater than baseline value, as were hematocrit and hemoglobin intensity. After hemodialysis, these rheological properties returned to their baseline values. These data suggest that hemodialysis would also have a positive effect on microcirculation. This was confirmed by the direct observation of the vessels of the eye, before and after hemodialysis.

In vitro studies of donors' blood were also performed before and after it was perfused through SKN-2M. This was done with non-oxygenated blood and also with blood which had been oxygenated for 10 minutes, during which partial oxygen pressure increased an average of 100% over starting level. In vitro dialysis of non-oxygenated blood led to significant decreases in most of the rheological parameters, with the exception of hemoglobin and hematocrit. This procedure decreased blood toxicity by a mean of 50%. Combination of blood oxygenation and hemodialysis further decreased the value of the rheological parameters and toxicity. The authors suggest hemodialysis as a countermeasure for rheological disorders in cosmonauts arising in response to a combination of space flight factors and illness.

Table titles: Table 1: Mean hemorheological parameters before and after hemodialysis in individuals undergoing hypokinesia with head-down tilt

Table 2: Parameters of microcirculation before and during hemodialysis on day 7 of hypokinesia with head-down tilt

Table 3: Hemorheological and hematological properties of donors' blood before and after hemodialysis

Table 4: Hemorheological and hematological properties of donors' blood before and after hemodialysis

## HUMAN PERFORMANCE

(See also: Neurophysiology: P335; Operational Medicine: P316)

### PAPERS:

P317(8/86)\* Khachatur'yants LS, Yepishkin AK.

**Work capacity of operators with a tracking system under conditions of hypokinesia with head-down tilt.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 36-39; 1986.

[17 references; none in English]

Human Performance, Tracking

Humans, Operators, Males, Typology

Hypokinesia, Head-down Tilt; Neurophysiology, Central Nervous System

**Abstract:** In this experiment, 12 males, aged 18-34, were subjected to a 56-hour period of hypokinesia with head-down tilt ( $-10^{\circ}$  -  $15^{\circ}$ ). Before this treatment began, all subjects were trained to perform a tracking task using a cathode ray tube and a hand control. This task involved three target motion programs of increasing difficulty: simple motion; presence of lag time between control action and target response; and sinusoidal movement. After learning to perform the task in a seated position, subjects practiced it in a horizontal position with head slightly elevated. During hypokinesia, subjects were tested at task performance 16 times and their performance was evaluated on the basis of mean distance between stimulus and tracker. In addition, visual and auditory reaction and reproduction of time intervals were tested 12 times in each subject. Because performance on the time interval task is considered to reflect the balance between inhibitory and excitatory processes in the central nervous system, subjects were divided into groups on the basis of how they performed on this task. Group 1 (inhibitory process dominant) included those who underestimated time intervals in the baseline condition; Group 2 (excitatory processes dominant) overestimated the intervals; and Group 3 estimated them correctly. While undergoing hypokinesia, Group 1 individuals tended to further underestimate time intervals, and Group 2 individuals to further overestimate them; Group 3 subjects showed both responses. Subjects in Groups 2 and 3 were further subdivided on the basis of changes in their time estimation pattern under hypokinesia. Group 2a showed greater increase in their overestimation than Group 2b. Group 3a tended to underestimate intervals slightly while undergoing hypokinesia, while Group 3b tended to overestimate them slightly. Members of Group 1 and Group 2a showed the poorest performance on different versions of the tracking task during hypokinesia and also the longest reaction time. The authors conclude that the effect of hypokinesia with head-down tilt on the excitatory or inhibitory processes in the central nervous system is a function of central nervous system type. The best performance under this treatment was associated with operators who react with a moderate increase in excitatory predominance. [NB: the results on which these conclusions are based were obtained with very few subjects.]

**Tables:** Table 1: Performance parameters of operators undergoing hypokinesia with head-down tilt

Table 2: Comparison of the performance of operators undergoing hypokinesia with head-down tilt



P351(8/86) Stepanova LP, Rozhdestvenskaya VI.

**Characteristics of work capacity during performance of a monotonous task.**

Voprosy Psikhologii.

1986(3): 121-127.

[21 references; none in English]

Human Performance, Work Capacity, Assembly Line Task

Humans, Operators

Monotony

**Abstract:** The authors start from the proposition that there are two classes of criteria for defining work as monotonous, the authors conclude that there are two classes of such factors, those relating to multiple repetitions of the same action, and those relating to low level of sensory stimulation. Measures used or suggested to decrease monotony also fall into two classes, depending on which aspect of monotony is addressed. Previous work examining the effects of these two classes generally has revealed that measures directed at ameliorating the repetitiveness of monotonous work have led to improvement of the "objective" negative consequences of monotony, e.g., changes in pulse rate and reaction time. On the other hand, measures directed at increasing sensory stimulation during monotonous work, typically through the introduction of music, have tended to ameliorate the subjective effects of monotony such as decreasing reported fatigue. This led the authors to hypothesize that there are two distinct types of monotony: one that involves repetition of the same or similar stimuli or motions, and one that involves insufficient stimulation or movement. The experiments described below were designed to test this hypothesis. In the first condition, (N=15) characterized by both types of monotony, subjects performed simple assembly line operations involving 3-4 elements and lasting 3.7 seconds per operation. In the second condition (N=15), the operations performed were identical to those in the first, but stimulation deficit was reduced by playing music. In the third condition (N=24), repetitiveness was reduced by increasing the length of each operation to 36.7 seconds and reassigning workers to different assembly tasks 4-6 times during a shift. An objective index of work capacity was computed from data on muscular strength of the right hand, static muscular endurance, and latency of a simple conditioned motor response. The index was computed on the basis of mean number of instances where a measurement exceeded (was an improvement over) baseline data; remained unchanged; and was lower (worse) than baseline. Workers performed their tasks for four (presumably full working) days. The first day was considered a familiarization period. In the 3 subsequent days, 5 measurements were made each day (4 in condition 3): before the beginning of the shift, 1, 2 and 6.5 hours after the beginning of the shift, and after the shift ended. (In condition 3, the third measurement point was omitted.) Immediately after measurements were made, subjects were asked to rate their fatigue on a scale.

As presented in Table 1, where both monotony factors were present, the integrated index was lower than when a single factor was operative. When the two single factor conditions were compared, it appeared that the index dropped least when the repetitive nature of the task was improved (condition 3). The subjective assessment of fatigue was again most

# HUMAN PERFORMANCE

P351

affected when both monotony conditions were present condition 1. This parameter increased less in condition 2, where sensory deficit was improved, than in condition 3. The authors conclude that: 1) the relationship between objective and subjective measures of work capacity in performance of assembly line operations support the hypothesis that there are two different aspects of monotony; 2) repetitive monotony, occurring when the same operation must be repeated frequently, affects a number of physiological parameters of work capacity, and less strongly affects subjective sensations of fatigue; 3) sensory deprivation monotony, occurring when there is a deficit in meaningful stimulation, surfaces mainly in subjective assessments of fatigue, and less strongly in physiological parameters; 4) to minimize or prevent the monotony of repetition, the entire task structure must be changed. To minimize or prevent monotony caused by sensory deprivation, it may be enough to alter the working environment without changing the task itself.

Table 1. Changes in work capacity in various types of monotony.

Work capacity Parameter	Monotony Condition	Before shift	Measurement Points			After Shift
			During Shift			
			1 hour	2 hours	6.5 hours	
Integrated Index	Both aspects (Cond 1)	0	-0.25	-0.47**	-0.33*	-0.32
	Repetition (Cond 2)	0	-0.34	-0.36	-0.30	-0.27
	Deprivation (Cond 3)	0	-0.08	--	-0.25*	-0.23
Fatigue Assessment	Both aspects (Cond 1)	0.5	0.4	1.67**	2.3	2.5
	Repetition (Cond 2)	0.06	0.06	0.22	1.3***	1.78**
	Deprivation	0.2	0.4	--	1.82***	2.3*

\* difference between measurement and preceding measurement significant,  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

P355(8/86) Dikaya LG.

**Characteristics of regulation of an operator's functional state during adaptation to special conditions.**

In: Lomov BF, Zabrodin YuM.

Psikhologicheskiye problemy deyatel'nosti v osobnykh usloviyakh

**[Psychological problems of performance under special conditions].**

Moscow: Nauka; 1985. (See abstract M86, this issue.)

[pages 63-90; 29 references; 3 in English]

Human Performance, Psychology, Functional State; Neurophysiology, EEG

Humans, Operators

Adaptation, Special Conditions, Fatigue, Sleep Deprivation

Abstract: "Special conditions" are described by the author as relating specifically to job performance, and as less extreme and stressful than "extreme conditions." Special conditions demand development or adaptation of functional systems of job skills that have been acquired under ordinary conditions. When special conditions are present for only a short time, ordinary job skills may be applied to their performance, with no adaptive changes made. However, if special conditions are operative for prolonged periods, more capable workers will develop new functional systems for job performance. This paper describes a study of the regulation of functional states related to job performance under special conditions. A 3-day continuous work schedule (sleep deprivation) was employed as a model of these conditions. This model was selected on the basis of its relevance to spaceflight. To make flight simulation more realistic, the work stations, food and water, relative hypodynamia and relative sensory deprivation of cosmonauts were also reproduced. Functional state was assessed by means of self-rating and polygraphy, as well as by measuring heart rate, respiration rate, GSR, and EEG. The experimental group, consisting of 9 people, was exposed to a 17-minute autogenic training (AT) tape, the first part of which was directed at relaxation and stress dissipation, while the second portion was directed at normalization of psychological state and restoration of work capacity. These individuals had undergone preliminary AT training, including a special exercise intended to stimulate work capacity under fatigue. The subjects listened to the tape 6 times during the experiment, beginning on day 2. A control group of 9 subjects were allowed to sleep or rest during that period. Subjects in both groups, aged 19-42, were apparently healthy. The research was performed in an isolation chamber that simulated prolonged uninterrupted job performance by a 3-member crew working under emergency conditions. The 3-day period was divided into 6 12-hour shifts filled with a variety of tasks. Measures were taken to motivate the subjects (material rewards based on performance, appeals to desire to excel).

The author states that her results support the following conclusions.

Three stages occurred during the uninterrupted 72 hour work period: reliable task performance lasting for the first 36 hours of the period; adequate performance of only the simplest tasks accompanied by sharp decreases in performance of the more complex and responsible tasks, lasting from 36 to 48 hours; effective performance only in the presence of specific psychological stimulation (either AT or socially mediated support), lasting from 48 hours to experiment termination. The experiment demonstrated the stimulating effects of AT in increasing the reliability of operator performance. These effects manifested themselves in the following ways:

P355

stabilization of visual resolution capacity; restoration of baseline values of the threshold critical flicker-fusion frequency; decrease and stabilization of latency of motor response to an auditory stimulus. Autogenic training had a beneficial effect on memory, cognitive image structure, information processing speed, and overall operator performance overall. Comparison of baseline EEGs of subjects undergoing AT with control subjects demonstrated that AT led to a state at the beginning of day 3 of the sleepless period which came close to compensating for fatigue: alpha rhythm activity increased along with theta and delta rhythms. Correlational analysis of EEG records made it possible to identify the stage where AT modified functional states and to determine its continuing effects on functional state. AT appeared to increase the level of activation in the brain, and was particularly effective when the subject was in a state of extreme fatigue, toward the end of the second and the beginning of the third day of sleep deprivation. Listening to the AT tape was associated with increase in theta wave activity and concurrent decrease in alpha wave. The effectiveness of AT is directly related to amount of training received in AT techniques. Subjects who received more preliminary training in AT displayed longer periods of brain activation and enhanced task performance in response to the AT tape. It is concluded that operators, including cosmonauts, should receive training to develop skills in psychophysical self-regulation under extreme conditions, in addition to their regular job training.

Figures: Figure 1. Types of adaptation in operators undergoing a 72-hour period of uninterrupted work.

Figure 2. Changes in the value of the coefficient of correlation between the frontal and visual regions of the right hemisphere during performance of autogenic exercises.

Figure 3. Changes over time in of EEG rhythms in the frontal region ( $F_4/A$  and EEG coherence spectrum between the frontal and the visual regions of the right hemisphere during AT exercises ( $F_4/O_2$ ))

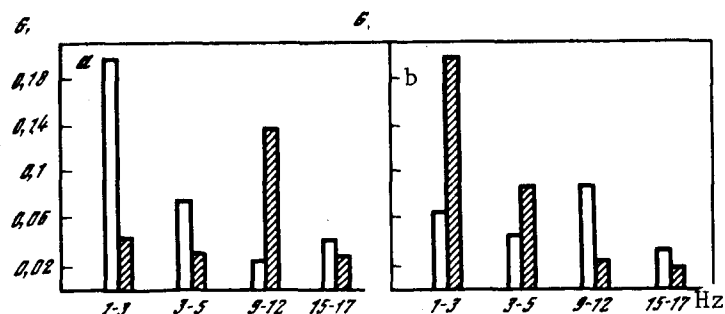


Figure 4. Amplitude?? of EEG rhythms in the frontal region of the right hemisphere. White bars -- before AT; Crosshatched bars -- after AT; a -- in an alert state; b -- in a state of extreme fatigue.

## HUMAN PERFORMANCE

### MONOGRAPHS:

M86(8/86) Lomov BF, Zabrodin YuM.

Psikhologicheskiye problemy deyatel'nosti v osobykh usloviyakh  
[Psychological problems of performance under special conditions].

Moscow: Nauka; 1985.

[232 pages; 35 figures; 13 tables; 262 references; 25 in English]

Affiliation: Institute of Psychology, USSR Academy of Sciences

**Key Words:** Psychology, Stress, Functional State, Self-regulation, Training, Human Performance, Operators, Extreme Conditions, Work Capacity, Man-machine Systems

Annotation: This collection presents work on the topic of "psychological problems of performance under special conditions." It contains papers devoted to the problems of work capacity, stress, self-regulation, and the measurement and regulation of performance under special working conditions. Issues related to the modeling of performance under such conditions are also discussed and theory and methods for designing man-machine systems for use in stressful conditions are analyzed. This work is intended for psychologists and computer designers.

### CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

Zabrodin YuM., Zazykin VG. Major trends in research on performance of a human operator under special extreme conditions (in lieu of an introduction) (5)

SECTION 1: GENERAL AND METHODOLOGICAL PROBLEMS IN THE STUDY OF OPERATOR PERFORMANCE UNDER SPECIAL AND EXTREME CONDITIONS (17)

Zazykin VG. Application of the principle of invariance to the analysis and design of man-machine systems (17)

Denisov VA. Comparative analysis of operator performance and performance breakdown (38)

Dikaya LG. Characteristics of the regulation of an operator's functional state during adaptation to special conditions (63)

Popov AK. General and particular aspects of the problem of human work capacity (90)

Golikov YuYa. Problems of occupational training and job design for inspectors of moving objects (104)

## HUMAN PERFORMANCE

### SECTION 2: THEORETICAL AND APPLIED ISSUES IN THE STUDY OF OPERATOR PERFORMANCE UNDER SPECIAL AND EXTREME CONDITIONS (116)

Nitrofanov BN. Research on the mechanism underlying regulation of sensorimotor interaction under special conditions (116)

Nikonov AV. Psychological problems of acoustic diagnosis of the functional state of operators (136)

Antonov GI. Dynamics of the mental image and resistance to interference on the part of an operator (153)

Shkoporov NB. The effect of limited closed space on the perception of invasion of personal space of a human operator during joint performance of tasks (168)

Golikov YuYa, Kostin AN. A method for representing the structure and dynamics of performance for design of control protocols and operator training programs (183)

Bannykh NS. [Issues relating to] Optimization of training of operators for performance in emergency situations (196)

Chursipov VA. The use of criteria of efficiency of the components of a psychological performance system in the design of training devices (206)

Varashkevich SA, Cherenkova YeA. An investigation of certain aspects of cognitive performance of a human operator in altered functional states (215)

Bedzyuk SV. An analysis of methods used for maintaining and reestablishing job skills of operators using high-tech systems under special conditions (222)

## HUMAN PERFORMANCE

M90(8/86) Medvedev VI, editor.

Fiziologicheskiye mekhanizmy optimizatsii deyatel'nosti

[Physiological mechanisms for optimizing performance]

Leningrad: Nauka; 1985.

[134 pages; 21 tables; 12 figures; 341 references]

Affiliations: Scientific Council of the USSR Academy of Sciences and Academy of Medicine on Human Physiology; I.M. Sechenov Institute of Evolutionary Physiology and Biochemistry

**Key Words:** Human Performance, Man-machine Systems, Job Performance, Psychophysics, Stress, Fatigue, Personnel Selection

Annotation: This collective monograph is devoted to the optimization of the performance of automated mechanized jobs. Issues related to the optimization of shift work, typical of such industries as oil and gas extraction, geologic surveying, etc. are examined. The psychophysical issues considered in this book concerning the development of job specifications, and in particular, those related to number of operators working with modern highly automated technological apparatus, have not only applied, but also theoretical implications. Also considered are issues relating to borderline functional states such as stress and exhaustion and optimization of the performance of older workers.

### CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Chapter 1. Psychophysiological issues in performance optimization. V.I. Medvedev (3)

Chapter 2. Physiological aspects of work performed by crews on watch??. S.G. Krivoshchekov (21)

Chapter 3. Study and optimization of human sensorimotor performance in industry. A.Zh. Yurevits, et al. (37)

Chapter 4. Issues in the optimization of operator work. V.S. Aver'yanov, et al. (49)

Chapter 5. Optimization of job performance in arid zones. I.M. Mommadov, et al. (75)

Chapter 6. On optimizing the job performance of older individuals. A.L. Reshetyuk (85)

Chapter 7. Methodological approaches to the psychophysiological justification for job specifications in tasks involving instrumentation. K.G. Kapustin (97)

Chapter 8. Issues in occupational adaptation and occupational selection in industries involving extreme conditions V.P. Grebnyak (105)

References (120)

## HUMAN PERFORMANCE

M94(8/86) Popovich PR, Gubinskiy AI, Kolesnikov GM.

### **Ergonomic support of cosmonaut performance.**

Moscow: Mashinostroyeniye; 1985.

[272 pages; illustrated]

**Key Words:** Human Performance, Cosmonauts, Systems Analysis, Man-machine Systems, Cosmonaut Training, Mathematical Modeling, Personnel Selection

**Annotation:** This monograph offers a systems analysis of changes in the types of human performance in space. A new mathematical device (functional nets) is described, and used to demonstrate methods for solving the problem of ergonomic support of cosmonaut performance. This monograph is intended for design engineers interested in the design and utilization of spacecraft and in cosmonaut training.

## CONTENTS

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

### **Chapter 1. Space as a sphere of activity (work).(5)**

- 1.1 The tendency to expand the types of work cosmonauts perform (5)
- 1.2 Characteristics of human states and human performance in space flight (14)
- 1.3 Analysis of space flight experiences and developmental tendencies (21)
- 1.4 Fundamental issues related to the ergonomic support of cosmonaut performance (27)

### **Chapter 2. Methodological studies of man-machine systems.(32)**

- 2.1 Fundamental principles of systems analysis and development of man-machine systems (32)
- 2.2 Basic terms and concepts (37)
- 2.3 The role and place of man in man-machine (called ergatic) systems (47)

### **Chapter 3. A systems analysis of "cosmonaut-technology" complexes and of human performance (55)**

- 3.1 A morphological systems analysis of "cosmonaut-technology" complexes (55)
- 3.2 Evolutionary-genetic analysis of human performance and a baseline psychophysiological model (67)
- 3.3 A functional systems analysis of "cosmonaut-technology" complexes (80)
- 3.4 An axiological systems analysis of ergatic systems (92)
- 3.5 An analysis of the effects of specific space flight factors on cosmonauts (99)



M94

**Chapter 4. Mathematical models of elements in functional networks. (113)**

- 4.1 General principles for constructing mathematical models of the elements of functional nets (113)
- 4.2 A baseline model of the functioning of ergatic systems (117)
- 4.3 Models of the functioners?? (128)
  - 4.3.1 A model of the working functioner (128)
  - 4.4.1 A model of the alternative functioner (132)
- 4.4 Models of the cybernets (137)
  - 4.4.1 Models of planner cybernets (137)
  - 4.4.2 Models of organizer cybernets (142)

**Chapter 5. Description and evaluation of ergatic (man-machine) systems using functional networks. (145)**

- 5.1 Basic rules for constructing functional networks (145)
- 5.2 A general methodology for evaluating the efficiency, quality, and reliability of the functioning of ergotechnological systems (151)

**Chapter 6. The ergonomic support system. (163)**

- 6.1 Principles for constructing ergonomic support systems (163)
- 6.2 Ergonomic design (169)
- 6.3 Issues in personnel selection and training (174)

**Chapter 7. Applied methods for solving problems in ergonomic support. (182)**

- 7.1 Optimization of ergotechnological systems (182)
- 7.2 Modeling of ergatic systems (189)
- 7.3 Methods for solving problems in ergonomic design (194)

Conclusion. (199)

Appendix 1. Chronology of expansion of work performance in space (200)

Appendix 2. Summary of data on duration of work in space (1961 to 1983 inclusive) (236)

Appendix 3. A methodology for deriving formulae and evaluating parameters for functional structures described by a base graph with two types of constraints (244)

References (265)

## IMMUNOLOGY

### PAPER:

P311(8/86) Surkina ID, Orlova ZS, Orlova GS, Borodin YuV, Dobrina SK, Shestakova SV, Kotelevtsev SV.

#### **Changes in immunity under stress.**

Fiziologiya Cheloveka.

12(3): 460-464; 1986.

[26 references; 15 in English]

Affiliation: All-Union Scientific Research Institute of Physical Culture, Moscow; Lomonosov State University, Moscow

Immunology, Immunity, T-cells, Cell Membrane, Alpha-tocopherol

Humans, Athletes, Skaters, Men and Women

Psychology, Stress; Physical Exercise, Countermeasures; Nutrition

**Abstract:** In this experiment, 20 male and female speed skaters, aged 19-27, were observed 2 months after the end of their competitive season. A control group of male nonathletes of comparable age was also examined. The percent and absolute concentration of T-cells in the blood was measured in both groups by noting the spontaneous formation of rosettes with sheep erythrocytes. Other parameters recorded included percent of active rosettes, blast transformation of lymphocytes in response to mitogen phytohemagglutinin (PHA) (reflecting the proliferation capability of T-cells). The state of the lymphocyte cell membrane was assessed through spectrofluorometric measurement of the concentration of alpha-tocopherol. Alpha-tocopherol concentration in blood plasma was also measured. Results indicated that, although the athletes were no longer under physical or emotional stress, the values of their immunological parameters were substantially below those of the control group. This was also the case with regard to alpha-tocopherol content in the cell membrane. However, concentration of alpha-tocopherol in blood plasma was normal. There was no correlation between the alpha-tocopherol content of the lymphocyte membrane and of the blood plasma for the athletes. The authors hypothesize that the deficit of alpha-tocopherol in the lymphatic membrane provides the mechanism for diminished immunological competence in response to stress. This alpha-tocopherol deficit in turn may be caused by increased lipid peroxidation leading to decreased levels of polyunsaturated fats in the lymphatic tissue. The authors suggest dietary supplements of both Vitamin E and polyunsaturated fats as a countermeasure to the effects of physical and emotional stress on immunological competence.

**Table and Figure Titles:** Table: Parameters of T-system immunity and concentration of alpha-tocopherol in blood plasma and lymphocyte membrane of athletes and members of a control group

**Figure:** Concentration of alpha-tocopherol in the lymphocyte membrane and blood plasma in athletes exposed to stress, and in members of a control group

P349(8/86) Asadullayev MM.

**Clinical immunological changes in vibration sickness.**

Gigiyena Truda i Professional'nyye Zabolevaniye.

1986(3): 54-56.

[9 references; 4 in English]

Affiliation: Institute of Sanitation, Hygiene, and Occupational Diseases,  
Ministry of Health of the Uzbek SSR, Tashkent.

Immunology, B- and T-lymphocytes

Humans, Males, Patients

Habitability and Environment Effects, Vibration Sickness

**Abstract:** This study analyzed the immunological characteristics of 87 male patients (aged 30-50) with occupationally related vibration sickness and compared them to those of 20 healthy counterparts. The following immunological parameters were assessed in both groups: quantity of circulating T-lymphocytes, quantity of B-lymphocytes, and concentration of class A, G, and M immunoglobulins. It was found that 92% of those suffering from vibration sickness showed significant immunological abnormalities. The subjects with vibration sickness had fewer circulating T-lymphocytes, accompanied by decreased blast transformation capability. On the other hand, this same group of patients showed an increase in the relative and absolute quantity of B-lymphocytes, as well as an increase of G and A immunoglobulins in blood serum. It is noted that a decrease in T-lymphocyte levels would retard regenerative processes, increasing physiological aging, which plays a role in vibration sickness. The magnitude of the changes noted in the immunological parameters depended on the severity of the vibration sickness. Those recovering from the illness showed a tendency for these parameters to normalize. It is suggested that immune function can be used as a secondary criterion for diagnosis of severity of vibration sickness.

**Tables:** Table 1: Quantity of T- and E-rosette forming lymphocytes in patients with vibration sickness.

Table 2: Quantity of T- and B-rosette forming lymphocytes as a function of severity (stage) of illness

## LIFE SUPPORT SYSTEMS

### PAPERS:

P314(8/86) Popova AF, Kordyum YeL, Nechitaylo GS.

**Submicroscopic organization of chlorella cells growing in space for 9 days on "Salyut-6."**

In: Kovrov BG, Kordyum VA, editors.

Mikroorganizmy v iskusstvennykh ekosistemakh.

[Microorganisms in artificial ecosystems].

Moscow: Nauka; 1985.

[Pages 66-71; 18 references; none in English]

Life Support Systems, CELSS, Viability

Microbiology, Chlorella

Space Flight Factors, "Salyut-6"

Abstract: Cultures of Chlorella vulgaris (line LARG-1) in an organic medium with 0.17% agar were flown on board the "Salyut-6" for 9 days, after which they were fixed and compared to controls. Flight cultures had no more nonviable cells than controls and electron-microscopy showed that the ultrastructure of the nucleus and cell mitochondria of the flight cultures did not differ from those of the controls. The chloroplasts of the flight cultures generally contained a well-formed membrane system. However, the amylogenic covering of the pyrenoid was absent or minimal in a significant number of experimental cells. The structure of the thylakoids remained intact. Starch reserves were frequently absent in these cells, indicating a disruption of carbohydrate metabolism. In addition, electron transparent zones, 0.2-1.5  $\mu\text{m}$  in size, appeared in the stroma of the plastids of the flight cultures. Some of the experimental cells had undergone a significant degree of vacuolization: not only were the size of the vacuoles increased in comparison to the controls, but frequently the vacuoles contained myelin-like membrane structures suggesting an intensification of lytic processes. Vacuolization occurred not only in vegetative cells at various stages of development, but also in autospores. In approximately 3% of the flight cells aberrations were noted during cell division and autospore formation, involving the formation of autospores which were irregular in size, as well as multinucleate cells. In such cells the Golgi apparatus was typically poorly developed. Some flight cells contained larger drops of lipids than was typical of control cells. Since the changes noted occurred in only a small proportion of flight cells, the authors concluded that the development of Chlorella in space is satisfactory, however, the presence of these changes do testify to certain inhibitory effects of space flight factors.

P353(8/86) Sidorenko PG, Martyn GM, Mikeladze GG, Podlutskiy AG.

**Potential for using cell cultures of higher plants in a life support system.**

In: Kovrov BG, Kordyn VA, editors.

Mikroorganizmy v iskusstvennykh ekosistemakh.

**[Microorganisms in artificial ecosystems].**

Moscow: Nauka; 1985. See M78, Issue #7.

[pages 117-121; 7 references; none in English]

Life Support Systems, CELSS; Nutrition

Botany, Higher Plants, Soy, Peas, Cabbage, Broccoli, Dill, Basil, Jerusalem Artichokes, Cell Cultures

Cultivation Conditions, Sensory Characteristics, Chemical Composition

**Abstract:** Cell cultures from higher food plants are good candidates for inclusion in a CELSS (Closed Ecological Life Support System). Such cultures are considered to be relatively immune to the negative effects of weightlessness on parent plants. They are highly adaptive, possess high metabolic lability, and are capable of various types of biosynthesis. Technology exists for cultivating such cultures under either heterotrophic or phototropic conditions. Previous flight studies revealed no substantial effects of orbital flights on higher plant cell cultures. Some effects of simulated space flight conditions (i.e, vibration and acceleration) were found to have reversible effects on the morphology and functional activity of culture components. Clinostasis led to some restructuring of the topography of organelles when illumination conditions were manipulated, but no other major effects were detected. The study described here analyzed the nutritive value of a number of food plant cell cultures from the point of view of their use as food in a space CELSS. A culture from the hypocotyl of soy plants was grown heterotrophically. The culture was odorless, with a sweetish, raw taste. Chemical analysis showed the dry weight to be 12.16% protein. Electron microscopy revealed evidence of active biosynthesis of proteins and lipids. This culture was considered suitable for use as food, after culinary processing. Cells from the bulb of a Jerusalem artichoke were cultured in the dark. The culture smelled like raw potatoes, and had a sweetish almost neutral taste and a mealy consistency. The proportion of reducing substances was 20.5% of dry weight, while the proportion of raw protein (13.24%) exceeded that of soy. Evidence of intense biosynthetic activity was found. The culture was considered suitable for use in cooked dishes or salads with no further processing. Cells from dill leaves were grown in the light. The culture smelled like fresh greens without specific dill odor. The taste was neutral and delicate. Analysis revealed a substantial amount of lipids. The culture is considered suitable for use in food dishes. Cultures of pea, cabbage, broccoli and basil all proved suitable for use as food in space flight CELSS.

## LIFE SUPPORT SYSTEMS

P354(8/86) Antonyan AA, Sukhova NN.

**Evaluating the composition of the biomass of Chlorella and its energy content in a model of a "man-algae-mineralization" life support system.**

In: Kovrov BG, Kordym VA, editors.

Mikroorganizmy v iskusstvennykh ekosistemakh.

**[Microorganisms in artificial ecosystems].**

Moscow: Nauka; 1985.

[pages 134-137; no references]

Life Support Systems, CELLS

Botany, Microbiology, Algae, Chlorella

Nutrition, Heat of Combustion

**Abstract:** Two important indicators of the success of human biological life support systems based on algae are the quality and quantity of the synthesized biomass and its energy content (caloric value). This study evaluated this parameter by burning biomass and measuring its heat of combustion. Heat of combustion in a Chlorella based system was measured directly and by estimates using a calorie coefficient based on the proportion of components (protein, lipids, and carbohydrates) in a biomass sample. Analysis of data obtained by these two methods established that there were no significant differences between the two values for heat of combustion. This study also involved analysis of the relationship between biomass composition and caloric value on the one hand, and mineral content (nitrogen sources and levels) and illumination conditions on the other, under continuous intensive cultivation of the algae over the course of 54 days. It was found that heat of combustion is independent of illumination levels at three different illumination levels (35, 133 and 256 W/m<sup>2</sup> photosynthetically active radiation) and with light sources producing three different spectra. Heat of combustion did differ significantly as a function of nitrogen source (nitrates, urea, and ammonium nitrate), with nitrates yielding 5.6 kcal/g and the other two sources 5.9 kcal/g. These high values are associated with increased synthesis of lipids and protein with high caloric value in the algae cells and high levels of reduction. Values for heat of combustion and biomass composition remained relatively constant over time when Chlorella was cultivated in a closed system for more than 35 days and when it was used as a component of a "man-algae-mineralization" life support system for 30 days. Heat of combustion and productivity of Chlorella were approximately parallel over time. When the supply of nitrogen to the Chlorella was reduced to 70% of the standard, relative production of carbohydrates increased and heat of combustion decreased.

**Table:** Composition of the biomass Chlorella and its energy content (caloric value) when grown on media with different nitrogen sources.

**Figure:** Changes over time in heat of combustion of the biomass and productivity included in a "man-algae-mineralization" system

**MONOGRAPH:**

M91(8/86) Glushko AA.

Kosmicheskiye systemy zhizneobespecheniya: Biofizicheskiye osnovy proyektirovaniya i ispytaniya.

**[Space Life Support Systems: Biophysical principles of design and testing].**

Moscow: Mashinostroyeniye; 1986.

[304 pages]

Affiliation: Not cited.

**Key Words:** Life Support Systems, Cosmonauts, Water, Food, Heating; Metabolism, Homeostasis; Biophysics; Work Capacity, Exercise; Body Fluids, Nutrition

Annotation: This monograph presents the basic biophysical principles underlying the design and testing of life support systems for manned spacecraft and special purpose modules, and the associated issues of maintaining and correcting metabolic homeostasis. The author analyzes the kinetics, thermodynamics, structure and topography of human heat, moisture and energy metabolism, which are determined by various types of physical homeostatic mechanisms. This monograph is intended for workers and engineers dealing with problems of life support in space and working on the design and development of life support systems.

**CONTENTS**

(Numbers in parentheses refer to page numbers in the original.)

Foreword (3)

Introduction (5)

**Chapter 1. Biophysical principles underlying the design of space life support systems (18)**

- 1.1 Biophysical principles relating to generation of an artificial atmosphere (18)
- 1.2 Providing food and water to spacecraft crews (25)
- 1.3 Sanitation and hygiene for cosmonauts (35)
- 1.4 Thermal conditions in manned spacecraft (42)

**Chapter 2. Biophysical principles underlying the testing of space life support systems (59)**

- 2.1 Physical principles on which methods are based (59)
- 2.2 Equipment for performing biophysical experiments (90)

**Chapter 3. Temperature fields and biophysical criteria for evaluating thermal conditions on manned spacecraft (145)**

- 3.1 The subject matter of thermal regulation and its physical interpretation (145)
- 3.2 Methodology for evaluating thermal regulation subsystems (147)
- 3.3 Human thermal regulation responses to conditions simulating life in space (160)
- 3.4 Integrated biophysical criteria for evaluating the function and performance characteristics of thermal systems (175)

M91

**Chapter 4. Fluid balance and biophysical criteria for evaluating water supply to cosmonauts (182)**

- 4.1 Regulation of fluid balance, a central problem in cosmonaut life support (182)
- 4.2 Biophysical aspects of the phenomena of the transfer of metabolic water (187)
- 4.3 Fluid balance and the physical parameters of artificial atmospheres (192)
- 4.4 Human fluid balance during physical activity (199)
- 4.5 Fluid balance under conditions simulating the stressful conditions of life in space (216)

**Chapter 5. Multidisciplinary biophysical studies of problems in habitability (221)**

- 5.1 Dynamics of transitional thermal processes (221)
- 5.2 Principles governing the transformation and transfer of heat resulting from metabolism (232)
- 5.3 Human thermal balance in physical activity (239)
- 5.4 Human energy, thermal and water balance on a space diet (246)

**Chapter 6. Biophysical principles underlying the testing of space suits and self-contained life support systems (253)**

- 6.1 Research goals(253)
- 6.2 Thermal and energy balance in the space suit (255)
- 6.3 Thermodynamic characteristics of work capacity of humans wearing a space suit (259)
- 6.4 Biophysical criteria for evaluating the effectiveness of self-contained life support systems and space suits under various conditions of conductive heat removal (266)
- 6.5 Biophysical criteria for controlling the operation of self-contained life support systems and work capacity of humans wearing a space suit (274)

**Chapter 7. Problems in space biophysics (286)**

- 7.1 The interconnections between the problems of ecological biophysics and space medicine (286)
- 7.2 Optimization methods and the standardization of devices for performing biophysical research (287)

References (296)



MAN-MACHINE SYSTEMS: See Human Performance: M86, M90, M94  
MATHEMATICAL MODELING: See Human Performance: M94

#### METABOLISM

(See also: Equipment and Instrumentation: P328, Life Support Systems: M91;  
Radiobiology: P346, BR8)

#### PAPERS:

P333(8/86)\* Potapov PP, Tikhmirova NA.

**Parameters of carbohydrate and lipid metabolism in rats during adaptation after a 30-day period of hypokinesia.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 85-87; 1986.

[12 references; 4 in English]

Metabolism, Lipids, Hyperlipemia, Recovery Period

Rats

Hypokinesia, Immobilization; Psychology, Stress

Abstract: This experiment was performed on 66 white male rats kept in individual immobilization cages for 30 days. A control group was maintained under normal laboratory conditions. Animals were sacrificed on day 30 of hypokinesia and on days 7, 15, 21, 30 and 60 of the recovery period. Blood serum and liver tissue were studied. Blood parameters measured were: concentrations of total lipids, cholesterol, phospholipids, triglycerides, and free fatty acids. Liver parameters were glycogen, total lipids, triglycerides and cholesterol. After 30 days of hypokinesia, a moderate degree of hypoglycemia, hypercholesterolemia, and an elevated level of free fatty acids were observed in the blood. Concentration of total lipids, triglycerides and cholesterol were elevated in the liver. Glycogen content, however, was decreased. After a week of recovery, blood sugar level was significantly above the norm, and hypertriglyceremia, and hypocholesterolemia were observed, while level of free fatty acids had dropped. In the liver, the concentration of lipids decreased and the amount of glycogen was 2.5 times normal and 10 times its level immediately after the hypokinesia. Significant hyperglycemia and decreased level of free fatty acids continued until the end of the experiment. The serum phospholipids dropped by day 30 of recovery and remained normal. From day 15 of recovery, the amount of triglycerides in the experimental group's blood did not differ from control level. Hypercholesterolemia was observed on days 21 and 60 of recovery. The amount of glycogen in the liver remained above normal throughout the experiment, while levels of total lipids and triglycerides remained depressed. The authors conclude that the time required for metabolism to return to normal may substantially exceed the duration of hypokinesia.

Tables: Table 1: Concentration of sugar in the blood and lipids in blood serum in rats in the recovery period after 30 days of hypokinesia

Table 2: Concentration of glycogen and lipids in the liver tissue of rats during the recovery period after 30 days of hypokinesia

## METABOLISM

### MONOGRAPH:

M89(8/86) Zor'kin AA, editor.

Metabolicheskiye protsessy pri nekotorykh ekstremal'nykh sostoyaniyakh  
[Metabolic Processes under Extreme Conditions].

Kishinev: Shtiintsa; 1985.

[154 pages; 28 tables; 16 figures; 276 references; 44 in English]

Affiliation: Moldavian Ministry of Health

**Key Words:** Metabolism, Hypokinesia, Psychology, Stress, Hypoxia, Adaptation, Radiobiology, Cardiovascular and Respiratory Systems, Musculoskeletal System

**Annotation:** This collection is devoted to the problem of metabolic adaptation to extreme environmental factors at a variety of functional levels. Certain pathogenic mechanisms underlying the development of changes immediately after traumatic injuries are discussed. Disruptions in the functioning of various systems under conditions of hypoxia of various etiologies are examined. Additional information is provided about the advantages of using certain research methods in the laboratory, as well as in clinical practice.

### CONTENTS

Zor'kin AA, Kurtser BM, Dovganskiy AP. Time course of shifts in free amino acids and corticosterone in tissue of the liver and myocardia of rats exposed to the combined effects of burns and irradiation (3)

Zor'kina AA, Kurtser BM. Comparative evaluation of the free amino acid pool of the liver in response to a variety of stress conditions (25)

Zor'kina TA, Selznev SA. Additional possibilities for evaluating microcirculation using contact microscopy. (29)

Zolotukhin SYe, Samsonenko RA, Kryuk YuYa. The effects of individual differences on the phase structure of traumatic shock in animals (33)

Lysyy LT. Aspects of the metabolism of skeletal muscles of rats immediately after trauma to the soft tissues (50)

Nastas IA. Metabolic pool of amino acids in renal tissues of rats in visceral shock. (63)

Babin AV, Gnatyuk PYa. Bioelectric activity of cardiac branch of the vagus nerve in anemic hypoxia (68)

Saulya AI. The effect of emotional stress on the myocardial contractility of rats adapted to physical exertion (71)

Saulya AI, Belkina LM, Markovskaya GI, Shimkovich MV. Cardiac contractility in animals undergoing long-term hypokinesia (77)

Bytka PF, Zhitsa VT, Krylov AP, Kasym MB, Tabak DV, Chikale YeT, Mel'nik IZ. Stimulation of microcirculation in diseases occluding the vessels of the extremities (87)

## METABOLISM

M89

Golovin VM. Compensatory-adaptive restructuring of the medulla of the adrenal glands in acute leukosis (92)

Goranskiy AI. Diurnal balance of osmotically active substances and water in animals with resectioned stomachs (96)

Dmitriyenko VD, Yuzefovich TS, Vasilos AF. The effects of long-term exposure to a combination of pesticides on certain indicators of renal function in rats (99)

Dovganskiy GA. The incidence of menopausal pathologies in women employed in industry and agriculture in Moldavia (103)

Yeshanu NV. The activity of certain anabolic and catabolic dehydrogenases in the adrenal cortices of animals with tumors (109)

Kiroshka LI. Vascularization and innervation of reconstructed urinary bladders after heteroplasty (113)

Matkovskiy KL, Kartalyanu YaK, Balan NK. The effect of diazepam on the concentration of potassium and sodium in the blood plasma and erythrocytes of white rats (115)

Mayakova NV. The activity of aminotransferase in blood and tissues in pregnant animals exposed to X-radiation (119)

Parfent'yeva VF, Beloded VG, Brus IG, Topor BM, Bedenkova OYe, Kiroshka LI, Moraru FV, Remizov VB, Bushmin FI, Poddubnyy IG. Formalin preserved heteroplastids in reconstructive surgery (124)

Popovich MI, Rudyagina YeP, Severin VV. Plasma lipoproteids in individuals working with pesticides (126)

Floka YeI, Igonina LV. The state of peroxidizing processes in renal tissues over the course of pregnancy (133)

Shiman II. The growth of RS-I transplanted tumors in animals in which thyroid function has been blocked with mercazolilum during pharmacological stimulation and inhibition of the central nervous system (139)

Summaries (143)

MICROBIOLOGY: See Exobiology: P347; Life Support Systems: P314, P354;  
Radiobiology: P357

#### MUSCULOSKELETAL SYSTEM

(See also: Equipment and Instrumentation: P328; Metabolism: M89)

##### PAPERS:

P323(8/86)\* Khomulo GV, Lotova VI, Chernyayev AN, Vinogradov IN.

##### **The effect of hypoxia on DNA synthesis and collagen concentration in regenerating skin.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 57-61; 1986.

[18 references; 8 in English]

Musculoskeletal System, Connective Tissue, Skin; Histology, DNA, Collagen  
Rats  
Hypoxia

**Abstract:** Two groups of male white rats were used in this experiment. The control group was wounded surgically through all the layers of skin encompassing 225 m<sup>2</sup> in area; the experimental group was given the same type of wound and, in addition, was exposed to hypoxia of 250-260 mm Hg in a barochamber for 8-10 hours per day throughout the experiment. DNA synthesis was studied in various areas of the regenerating skin through autoradiography using <sup>3</sup>H-thymidine. The isotope was introduced intraperitoneally 5 or 10 days after infliction of the wound, 3, 6 or 24 hours before the animals were sacrificed. The marked cell index was determined in 5 different zones. The quantity of collagen extracted from granulated tissue was determined colorimetrically. In addition the course of regeneration was monitored by measuring the wound and using histological preparations. Measurement of the wound indicated that hypoxia slows the process of healing. Histological analysis showed that hypoxia retarded the formation of granulated tissue, causing defects in the tissue that did form. Study of the marked cell index showed that hypoxia interfered with the ability of the cells to contain thymidine, indicating decreased synthesis of DNA. This effect was particularly pronounced in the epidermis. Ten days after the wound was inflicted, the differences between the control and experimental groups were somewhat less pronounced than they had been after 5 days but were still significant in a number of areas. In control animals collagen was at its maximum level 10 days after healing began, but began to decrease 15 days afterward; for animals exposed to hypoxia, collagen concentration was lower than that for controls on days 5, 10 and 15, and only reached its maximum 15 days after wound infliction.

**Table and Figure Titles:** Table 1: Width of various elements of healing wounds under conditions of hypoxia

Table 2: Marked cell index in epithelial and connective cells (24 hours after administration of <sup>3</sup>H thymidine)

Table 3: Concentration of collagen in granulated tissue during wound healing

**Figure:** Inclusion of <sup>3</sup>H-thymidine in nuclei of cells of the boundary zone of the epithelium and granulated tissue

## NEUROPHYSIOLOGY

(See also: Cardiovascular and Respiratory Systems: P320;  
Human Performance: P317, P355)

### PAPERS:

P319(8/86)\* Grigorova VK. (Bulgaria)

**The relationship between optokinetic nystagmus and optovestibular and vestibular autonomic tolerance.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 43-45; 1986.

[7 references; 6 in English]

Neurophysiology, Nystagmus, Asymmetry  
Humans, Individual Differences  
Vestibular Tolerance

**Abstract:** The author performed 2 experiments using as subjects 60 healthy individuals, aged 20-45, without abnormalities of vision, hearing or vestibular function. In the first experiment, 30 individuals were subjected to pseudoCoriolus stimulation for 10 minutes in order to determine their susceptibility to motion sickness. On the basis of their responses, subjects were divided into those who were tolerant of optokinetic stimulation (group 1) and those who were susceptible (group 2). Subjects in both groups were then subjected to optokinetic stimulation designed to evoke nystagmus and involving a field of vision of either 30° (image presented on television screen) or 110° (image presented on cylinder). All subjects were exposed to stimulation (motion of black and white stripes) at 5 rates (4, 14, 29, 45, and 65 degrees/sec), after which 15 subjects were exposed to stimulation at 8 rates (4, 14, 17, 22, 25, 36-38, 45-50 degrees/sec.). In the second experiment, 30 additional subjects were subdivided into three groups on the basis of tolerance of vestibular autonomic stimulation (apparently determined through Coriolus acceleration), with group 1 being most tolerant and group 3 least tolerant. Optokinetic nystagmus was evoked using alternating stripes moving at 5 different rates across a television screen (field of vision = 30°). In both experiments, subjects were required to count the stripes as they moved past the center of the screen. Nystagmus was measured through nystagmography. Asymmetry was determined using angular velocity of the slow phase and frequency for each direction, and was expressed as the percent of right or left nystagmus in relation to the sum of left and right nystagmus. The author believes that there are two types of optokinetic nystagmus: central and peripheral. Each type can be evoked by manipulating the field of vision in different ways. In these experiments the television screen was supposed to evoke central nystagmus, while the cylinder was supposed to evoke peripheral nystagmus. Results of experiment 1 showed that asymmetry of central nystagmus, as indicated by angular velocity, is more pronounced in people susceptible to motion sickness (group 2) than in people resistant to motion sickness. For both groups, asymmetry is more pronounced for central nystagmus than for peripheral nystagmus at higher angular velocities. No significant differences were found between groups or stimulation conditions for nystagmus frequency. In the second experiment, subjects most susceptible to motion sickness showed greater asymmetry in angular velocity of nystagmus than subjects in the other two

P319

groups. This difference was statistically significant only when angular velocity of stimulation was of  $45^{\circ}/\text{min}$ . The author concludes from this experiment that asymmetry of central nystagmus is significantly correlated with vestibular tolerance of Coriolus or pseudoCoriolus acceleration.

Tables: Table 1: Coefficients of asymmetry of the angular velocity of the slow phase of optokinetic nystagmus

Table 2: Coefficients of asymmetry of the angular velocity of the slow phase of central optokinetic nystagmus in individuals differing in vestibular autonomic tolerance

P322(8/86)\* Tigranyan RA, Kovalev VYu.

**The effect of long-term space flight on the concentration of polyamines in the brain of rats.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 53-57; 1986.

[11 references; 7 in English]

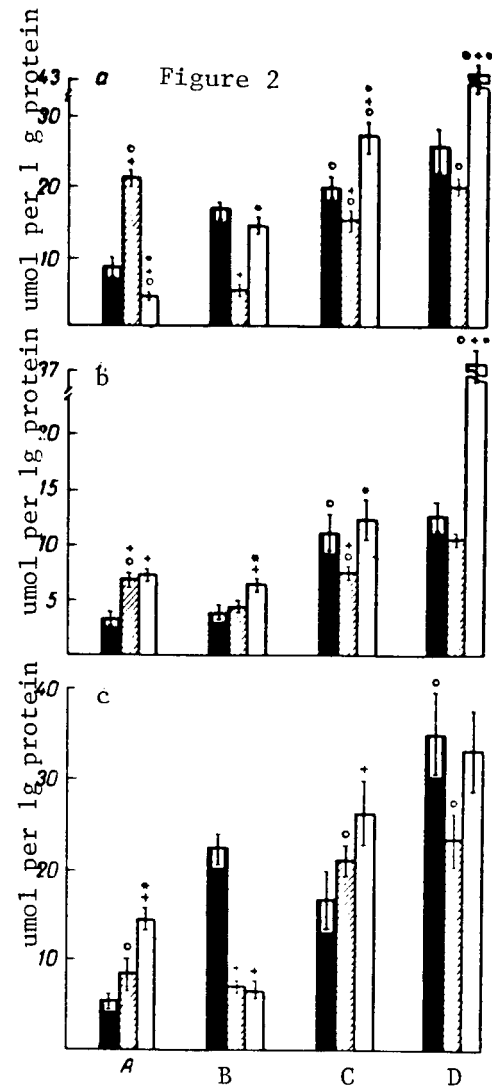
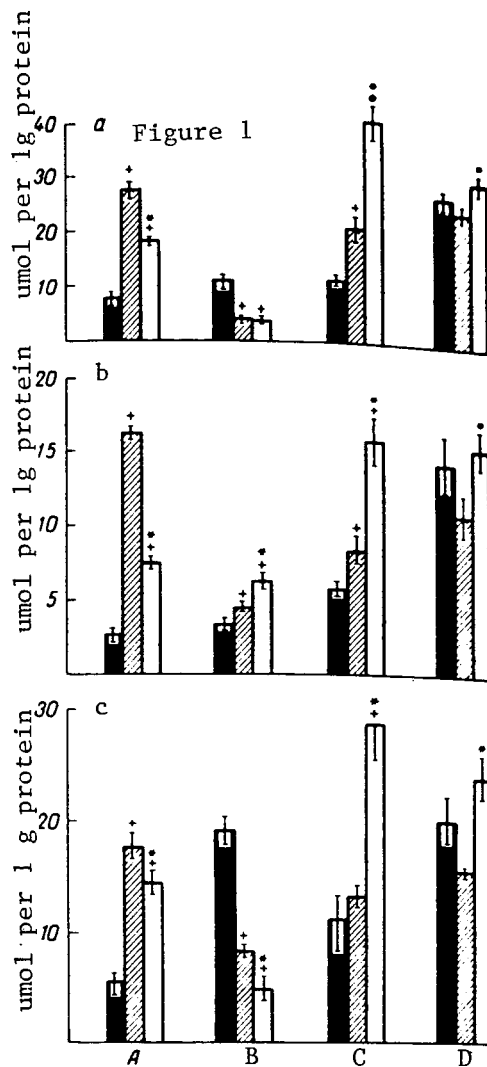
Neurophysiology, Brain, Polyamines

Rats

Spaceflight, Long-term, "Cosmos-1129"; Psychology, Stress

**Abstract:** In this experiment, Wistar rats were flown for 18.5 days in the "Cosmos-1129" biosatellite. Synchronous and vivarous control groups were also used. A portion of the animals were sacrificed either 6 to 8 hours or 6 days after landing. A portion of the group sacrificed on day 6 had also been subjected to 5 150-minute periods of immobilization subsequent to landing. Control and synchronous groups were also subjected to immobilization. There were 6-7 animals in each experimental and control group. Concentration of polyamines in (the cerebral hemispheres, cerebellum, medulla oblongata, and hypothalamus) were determined by ion-exchange chromatography followed by electrophoresis of the supernatant, obtained through centrifugation of homogenates. Changes in levels of polyamines are shown in detail in Figures 1-3. On the basis of these results, the authors draw the following generalizations and conclusions: the greatest changes in the flight animals occurred in the medulla. Putrecine and spermine, were the most and least affected, respectively. Immediately after landing, there were similar changes in the polyamine concentrations of the flight and synchronous groups, but these occurred in different areas of the brain. Polyamine levels in the cerebral hemispheres did not change in either the flight or synchronous groups, suggesting that normalization may already have occurred, or that capacity for reaction had already been exhausted. Immediately after landing, spermine concentration was elevated in all areas except the cerebellum in the flight group. The combination in the cerebellum of decreased spermine and increased spermidine (the source of spermine) could be explained by a weakening of the action of the enzyme sperminsynthetase. The increased spermine in other areas of the brain may have occurred for another reason. Six days after landing, normalization was not complete in the medulla, cerebellum and hypothalamus. In addition, levels of putrecine and spermidine in the cerebellum increased significantly over their immediate post flight values for the flight, but not the synchronous group. Although changes in the flight and synchronous groups were similar immediately after flight, they differed 6 days later. The authors interpret this as indicating that flight effects proper, are confounded by the effects of emotional stress (associated with landing) in the immediate post-flight period. Results with immobilization stress are interpreted as indicating that space flight factors affect the central nervous system in the same way as chronic stress. However, the nerve centers of the hypothalamus and medulla adapt more rapidly to these stress conditions. In the cerebellum and cerebrum the stress associated with weightlessness apparently led to changes in the state of the nerve centers affecting the stability of the protein synthesizing mechanism.

P322



Figures: Figure 1: Concentration of polyamines in various areas of the brains of rats immediately after a flight on the "Cosmos-1129" biosatellite. Here and in Figures 2 and 3: a -- putrescine; b -- spermidine; c -- spermine; dark bars -- control; cross hatched bars -- synchronous experiment; white bars -- flight; A -- medulla oblongata; B -- cerebellum; C -- hypothalamus; D -- cerebral hemispheres. Here and in Figures 2 and 3: statistically significant changes in comparison to control group are denoted by +, and between flight and synchronous groups by \*.

Figure 2: Concentration of polyamines in various areas of the brains of rats 6 days after landing after a flight on the "Cosmos-1129" biosatellite. Here and in Figure 3, differences significant with respect to levels obtained immediately after landing are indicated by °.



P322

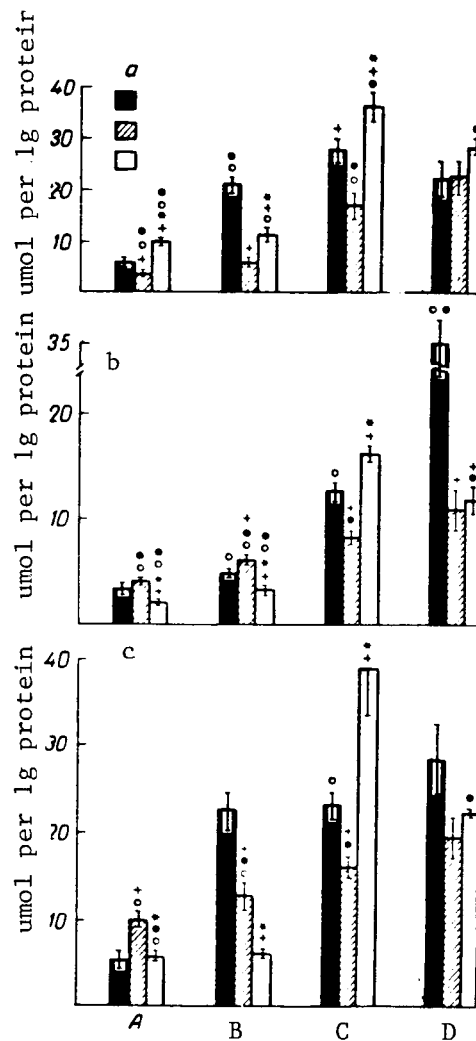


Figure 3. Concentration of polyamines in various areas of the brains of rats subjected to repeated immobilization after landing, 6 days after completion of a flight on the "Cosmos-1129" biosatellite. Significant differences between animals subjected and not subjected to immobilization are indicated by \*.

P335(8/86)\* Tychina VP, Nechayev AP.

**Bioelectric activity in the human brain during sleep deprivation.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 88-91; 1986.

[13 references; 2 in English]

Neurophysiology, Bioelectric Activity; Human Performance

Humans

Psychology, Isolation; Fatigue, Sleep Deprivation

**Abstract:** Three healthy individuals, aged 30-50, participated in this study. These subjects were held in isolation for 3 months and required to perform operator's work (compensatory tracking) every day. After adapting to isolation, they were studied during a 3-day period of sleep deprivation. EEGs were recorded with leads attached to the back of the head at 10:00 and 17:00 each day. During the first EEG, subjects were engaged in performance of tracking tasks, and during the second recording they were engaged in psychological tests. Baseline measurements were taken before and after each session, while the subject was at rest. EEG recording continued until subjects showed clear signs of falling asleep. General alertness was assessed on the basis of speech, performance of simple arithmetic problems and coordination. In addition the EEG, an EKG was recorded, and respiratory frequency and heart rate were also measured. Performance on the tracking task continued at a relatively high level throughout the sleepless period. However, clear effects of the treatment were observed on the EEG records, in particular, increase in slow synchronized waves during both task performance and relaxation. At the same time, fast waves were curtailed in amplitude. Pronounced individual differences were observed in the responses to sleep deprivation recorded by the EEG. EEG features characteristic of alertness continued at a fairly high level during tracking task performance, while properties more characteristic of transition to sleep occurred while subjects were filling in the blanks of psychological tests.

**Figure:** Temporal and amplitude relationship between the levels of bioelectric activity of the brain

P339(8/86)\* Gorgiladze GI, Samarin GI, Bryanov II.

**Interlabyrinth asymmetry, vestibular dysfunction and space motion sickness.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 19-31; 1986.

[121 references; 52 in English]

Neurophysiology, Vestibular Dysfunction, Space Motion Sickness; Personnel Selection

Humans, Cosmonauts, Literature Review

Adaptation, Interlabyrinth Asymmetry; Space Flight, "Salyut-6"

**Abstract:** Analysis of data from clinical and physiological examinations of cosmonauts makes it possible to examine disruption of the paired functioning of the labyrinths as one of the causes of space motion sickness. It is possible to examine differences in baseline levels of vestibular and otolithic asymmetry in the cosmonauts and associate these differences with space motion sickness symptoms. It is also important to consider that after return to Earth many cosmonauts showed increased levels of asymmetry in various parameters of vestibular functioning. As a rule, vestibular asymmetry was associated with symptoms of motion sickness, and the most pronounced symptoms were associated with the highest level of asymmetry, as indicated by nystagmus. In man and animals, the extreme case of surgical destruction of one labyrinth is associated with nausea, dizziness, vomiting, and other symptoms. While these symptoms abate with adaptation they do not disappear completely, and are particularly pronounced under various kinds of extreme conditions, including weightlessness induced by parabolic flight. The authors argue that some degree of initial vestibular asymmetry is virtually omnipresent, associated with (among other factors) differences in the weight of the otolith membrane, for which the central nervous system compensates under normal conditions by increasing inhibition of the dominant side and increasing facilitation of the other side. The extreme environmental factors associated with space flight disrupt this compensation, and cause a "new" vestibular asymmetry to arise. Contributing factors may include elimination of weight differences in the otolith membrane, disruption of canal-otolith interactions, asymmetrical hemodynamic and fluid shifts, development of significant hemispheric asymmetry, and stress. Adaptation to space flight conditions and the disappearance of space motion sickness symptoms are attributed by the authors to a new compensatory mechanism appropriate to the new asymmetry arising in weightlessness. When cosmonauts return to Earth, this new compensation is still in operation, leading again to an asymmetry and, thus, renewed symptoms of motion sickness. Laboratory data cited as confirming these results include relatively high levels of vestibular asymmetry, either natural or induced, on the parts of subjects who are prone to motion sickness. The authors do not claim that interlabyrinth asymmetry is the only mechanism leading to space motion sickness. They suggest a research program to further investigate the role of vestibular asymmetry in the genesis of space motion sickness, involving investigation of: 1) association between degree of otolith and canal asymmetry using a variety of vestibulometric methods (otolithometry, caloric irrigation, sinusoidal rotation, electrical stimulation of the labyrinths and optokinetic stimulation); and 2) the tendency toward development of kinetic, sensory and autonomic symptoms under normal circumstances, in response to a number of provocative tests, under stress, during simulations of space flight factors, and, especially

P339

during space flight itself. If the correlation turns out to be high, tests for interlabyrinth asymmetry might be used in the selection of cosmonauts.

Figures:

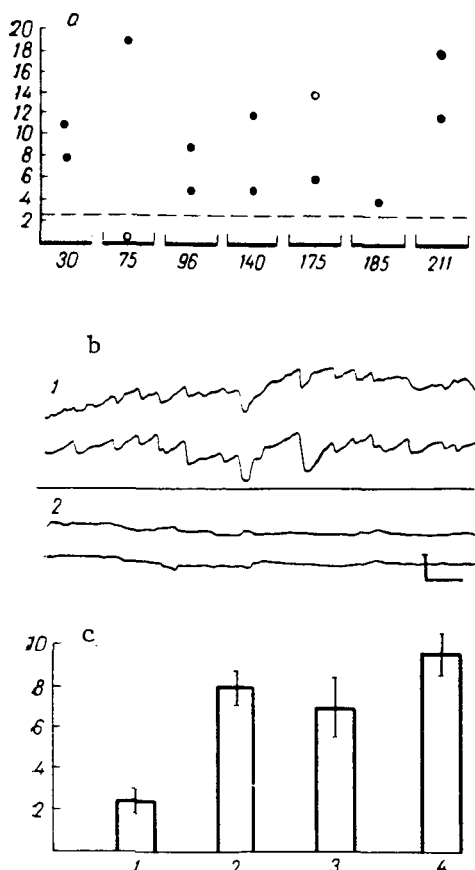


Figure 1. Manifestations of vestibular asymmetry in cosmonauts and healthy individuals exposed to simulations of various space flight factors.

a - otolith asymmetry in cosmonauts immediately after completion of orbital flights. Black circles indicate pronounced symptoms of motion sickness ; white circles indicate absence of such symptoms. Abscissa -- length of flight in days; ordinate -- degree of asymmetry manifested in ocular counterrolling (in degrees). Dotted line -- mean magnitude of this reaction in healthy males.

b - spontaneous nystagmus in crewmembers of "Soyuz-T-4"-"Salyut-6" complex in the dark in a sitting position 1 hour (1) and 56 days (2) after a 75-day flight. The upper and lower curves are electro-oculograms in the vertical and horizontal leads, respectively.

c - otolith asymmetry as shown by ocular counterrolling (in degrees) in healthy adults under normal conditions (1), after 182 days of hypokinesia with head-down tilt (2), after motion sickness induced by Coriolis and precessional acceleration (3) and in cosmonauts immediately after completion of long-term orbital flights.

P339

Figure 2. Differences in weight between the statoconia of the utricle (1) and sacculus (2) of the right and left labyrinth in 25 adult Esox lucius (common pike, in mg). In both cases,  $P < 0.05$ .

Figure 3. Hypothetical diagram explaining "initial" uncompensated vestibular asymmetry (I), compensation for it under normal conditions (II), the appearance of vestibular asymmetry and compensation for it under weightlessness (III and IV, respectively) and after return to Earth (V and VI).

Figure 4. Tolerance of Bryanov test (in minutes) under normal conditions and when a constant 5.0 Amp current is passed through the right labyrinth.

P341(8/86) Skoromnyy NA, Demchenko IT, Beketov AI, Moskalenko YuYe.  
**Cerebral circulation and oxygen pressure in conscious rabbits undergoing motion sickness.**

Fiziologicheskii Zhurnal SSSR im. I.M. Sechenova.

72(3): 352-356; 1986.

[15 references; 4 in English]

Affiliations: Medical Institute, Simferopol; Sechenov Institute of Evolutionary Physiology and Biochemistry, USSR Academy of Sciences, Leningrad

Neurophysiology, Cerebral Circulation, Oxygen Pressure; Cardiovascular and Respiratory Systems  
 Rabbits  
 Motion Sickness

**Abstract:** In this study, platinum electrodes were implanted in the brains of 17 rabbits, making it possible to measure both overall and local circulation, as well as  $pO_2$  in the cerebral cortex. Blood flow was measured in the frontal, occipital and temporal regions of the cerebral cortex on the basis of hydrogen clearance. Experimental procedures began 2 weeks after electrode implantation. Motion sickness was induced with variable linear accelerations at a frequency of 30-34 per minute for a period of 1 hour. Parameters were measured before the vestibular stimulation, at intervals of 5 to 10 minutes during, and for 1 hour after stimulation was terminated. The first experiment examined changes in cerebral circulation and partial oxygen pressure, while the second charted the effects of the experimental treatment on systemic blood pressure. No differences were found among the mean values for baseline blood flow in the 3 regions measured. Total cerebral blood flow was 12-19% lower than it was in the individual cortical structures. During vestibular stimulation significant hemodynamic changes were observed in the cortical structures. For example, total blood flow increased immediately after the treatment began and after 5 minutes had increased by a mean of 17% over baseline. The interval for the maximum increase in blood flow varied, but the modal interval was 10 minutes. Total cerebral blood flow remained elevated throughout the treatment and returned to baseline by 30-40 minutes after stimulation was terminated. Patterns of local blood flow were similar to that of overall blood flow, with the greatest increases occurring in the temporal and occipital regions. The general pattern of response to the stimulation involved an immediate increase in circulation in the temporal cortex, and gradual increases in the other regions studied. These increases were maintained until the termination of stimulation. The stimulation was associated with statistically insignificant decreases in  $pO_2$  in the 3 regions of the cortex. Changes in blood pressure showed no clear pattern and differed among animals. The authors conclude from this that a close relationship exists between cerebral circulation and vestibular stimulation; however, the mechanism underlying this connection cannot be determined unambiguously. One possible explanation for increased cortical blood supply in the absence of blood pressure changes is vascular dilation resulting from excitation of the cholinergic system in response to vestibular stimulation. Another postulated mechanism is increased excitation of neurons in the cortical area associated with the vestibular system (located in the temporal region) with spread of excitation to other areas. Consistent with this explanation is the increase of blood flow without a concomitant increase in  $pO_2$ , suggesting lack of compensation for

P341

oxygen metabolism. Further research on this effect should facilitate the development of motion sickness countermeasures.

Figures:

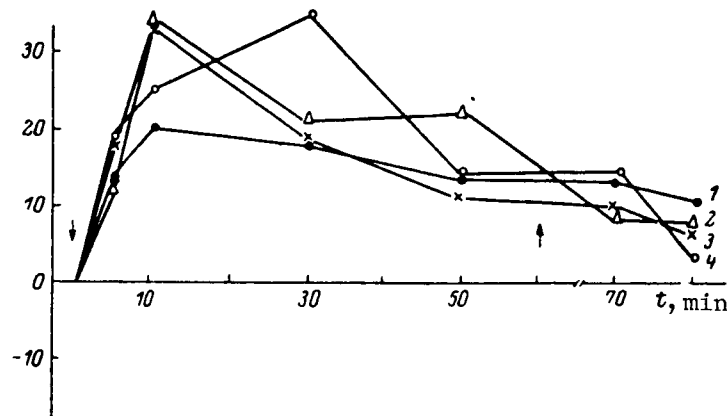


Figure 1: Changes over time in blood flow in cortical regions of the brain during induction of motion sickness.

Abscissa: time in minutes; Ordinate: changes in blood flow, in % of baseline. 1 - total blood flow; 2 - occipital; 3 - frontal; 4 - temporal region of the brain.

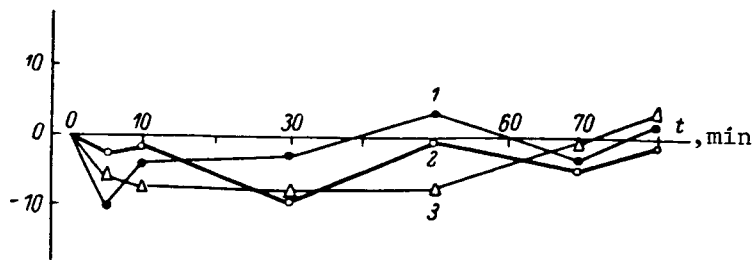


Figure 2. Changes over time in oxygen pressure in cortical regions of the brains of rabbits during induction of motion sickness.

Abscissa: time, in minutes; Ordinate: changes in polarographic current, in % of baseline. 1 - occipital; 2 - frontal; 3 - temporal regions of the brain.

## NEUROPHYSIOLOGY

P326(8/86)\* Karpov BA, Aleksandrov LG.

**A technique for calibrating oculograms.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 71-73; 1986.

[4 references; 1 in English]

Neurophysiology, Eye Movement

Humans, Males

Calibration Technique

**Abstract:** To eliminate the errors inherent in the traditional technique for calibrating oculograms during voluntary shifting of gaze from one target to another, the authors tested a technique involving visual tracking of a smoothly moving target. Compared to the standard technique, the proposed method was found to produce substantially less variability in measured eye movement parameter across trials.

**Table and Figure Titles:** Table 1: Errors (Variability) in fixation shifts by means of saccadic eye movements

Table 2: Characteristics of smooth tracking eye movements when target oscillation varies in frequency

Table 3: Value of G in tracking a target performing penduliform movements between two calibration points

**Figure:** Eye movement trace for a subject tracking a calibration target



## NUTRITION

(See also: Immunology: P311; Life Support Systems: P353, P354, M91)

### PAPERS:

P350(8/86) Bogdanov NG, Gvozdoval LG, Belakovskiy MS, Smirnova AN, Blazheyevich NV, Taraban'ko VM, Yuzhanskaya MG, Pastushkova LKh, Ziburkina TG, Pereverzeva OG.

#### **Vitamin levels in cosmonauts during preflight training and after completion of short-term space flights.**

Voprosy Pitaniya.

1986(3): 28-31.

[15 references; 10 in English]

Affiliation: Institute of Nutrition, USSR Academy of Medicine; Institute of Biomedical Problems, USSR Ministry of Health, Moscow

Nutrition, Vitamin Levels

Humans, Cosmonauts

Space flight, Short-term, "Salyut-6," "Soyuz"; Flight Training

**Abstract:** Vitamin levels in cosmonauts were determined by measuring their dietary intake, concentration of vitamins in the blood, and excretion of vitamins and their metabolites with daily urine, the activity of enzymes having vitamins as coenzymes, and the activation of these enzymes by their coenzymes. Daily renal excretion of thiamine, riboflavin, N<sub>1</sub>-methyl nicotinamide, ascorbic acid, and 4-pyridoxic acid was measured 1 month and 1-5 days before space flight, and on days 1-7 post-flight (duration from 4 to 13 days). Concentrations of vitamin A, carotenoids, vitamin B<sub>12</sub>, vitamin C, vitamin E and 25-hydroxycholecalciferol (25-HCC) in venous blood serum were measured 1 month preflight, and 1 day after return to Earth. In addition, activity of glutathione reductase of erythrocytes and its increase in response to the addition of FAD (FAD effect) was used as an estimate of level of riboflavin. Concentration of niacin was estimated by the concentration of nicotinamide coenzymes (NAD and NADP), and the level of thiamine was estimated by the activity of transketolases and by increase in this activity after the addition of thiamine diphosphate (TDP effect). Results of these measurements are presented in Tables 1 and 2. During the intensive conditioning and training period, 1 month preflight, mean vitamin levels generally fell within physiological norms (with the exception of decreased thiamine excretion). During the latter part of training, all cosmonauts were taking vitamin supplements; this was accompanied by increased secretion of vitamins and their metabolites. These results are interpreted as indicating adequate consumption of vitamins during the preflight period. In the postflight period, during which the cosmonauts continued to take vitamin supplements, excretion of vitamins decreased to the lower boundary of the norm in some individuals. Variance in vitamin excretion and blood levels was higher post- than preflight, suggesting the influence of individual differences in the metabolic reactions to extreme factors. While preflight - postflight differences in excretion of vitamins tended to be significant statistically, this was not the case with blood concentrations, because of individual differences in the direction of changes. However, mean blood levels remained within normal limits. The statistically significant decrease in the excretion of a number of vitamins during the postflight

## NUTRITION

P350

period suggests an increased vitamin metabolism and thus increased need for them postflight.

Tables: Table 1: Daily renal excretion of vitamins and their metabolites in cosmonauts pre- and postflight

Parameter	Preflight		Postflight		Physiological Norm
	1 month	1-5 days	Day 1	Day 2	
Thiamine, ug	337±16.8	599±49.6	285±35.1	310±36.3	150-300
N	(164)	(98)	(23)		
p		< 0.001	< 0.001	< 0.001	
Riboflavin, ug	479±31.0	619±52.5	343±91.6	434±52.4	300-1000
N	(164)	(98)	(23)		
p		< 0.05	< 0.05	< 0.01	
4-Pyrodoxic acid, mg	2.25±0.13	4.39±0.23	2.87±0.54	2.69±0.52	1.5-2.5
N	(138)	(96)	(23)		
p		< 0.001	< 0.01	< 0.01	
N <sub>1</sub> -methylnicotinamide, mg	9.39±0.34	13.23±0.52	10.8±1.16	10.0±0.80	7-12
N	(166)	(98)	(23)		
p		< 0.001		< 0.01	
Ascorbic acid, mg	25.0±4.4	58.1±5.7	--	--	20-30
N	(84)	(62)			
p		< 0.001			

Table 2: Concentration of certain vitamins in the blood of cosmonauts and activity of vitamin dependent enzymes pre- and postflight

Parameter	1 month preflight	Day 1 postflight	Norm
Vitamin A, ug/100 ml	45±1.5 (96)	60.8±4.5 (17)	30-70
p		0.001	
Carotenoids, ug/100 ml	156±5.6 (96)	179±11.6 (17)	80-230
Vitamin B <sub>12</sub> , pg/ml	743±55.7 (54)	619±59.3 (15)	200-1000
25-HCC, pg/ml	51.7±2.7 (74)	58.6±4.6 (15)	10-100
Vitamin E, mg/100 ml	1.56±0.05 (88)	1.48±0.07(15)	0.6-1.6
TDP effect, %	13.9±1.5 (49)	12.5±1.03 (13)	0-15
FAD effect, abs. units	1.08±0.03 (33)	1.08 ±0.03(11)	< 1.2
NAD+NADP, ug/ml	28.0±1.8 (70)	29.7±3.3(13)	28-44
Ascorbic acid, mg/100 ml	1.49±0.15 (45)	--	0.7-1.2

Numbers in parentheses refer to number of subjects.

## OPERATIONAL MEDICINE

(See also: Cardiovascular and Respiratory Systems: P375)

### PAPER:

P338(8/86)\* Ponomarenko VA.

**Stages in the development of the problem of flight safety in aviation medicine.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 12-19.

Operational Medicine, Flight Safety

Humans, Aircraft Crews

Theoretical Discussion

**Abstract:** In the early stage of flight medicine, the author of this very general article argues, the goal was to assure the physical safety of human beings in the cabin of the flight vehicle. The field has subsequently evolved and expanded and its contemporary goal is to assure the high performance of the entire system of which the human crew is a single component.

## OPERATIONAL MEDICINE

P330(8/86)\* Bokeriya LA, Sokolova NA, Konikova AS.

### **The role of oxygen in resuscitation**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 80-81; 1986.

[4 references; 2 in English]

Operational Medicine, Anoxia, Resuscitation

Animals, (Unspecified)

Oxygen, Chilling

**Abstract:** This paper presents a very brief review of the conclusions of a series of experiments studying the molecular mechanisms involved in the death due to anoxia, and conditions under which resuscitation is possible. The possibility of an accident in space causing acute hypoxia or death by anoxia makes this relevant to space medicine. The authors cite the following conclusions as being derived from their experiments: 1. After death occurs the process of renewal of biopolymers, (i.e., the synthesis and decomposition of proteins and nucleic acids) ceases abruptly in the organs studied (brain, cardiac and skeletal muscles, liver, kidneys, lungs, spleen, adrenal, thyroid and pancreas glands, blood, bile and urine). 2. Renewal of biopolymers ceased in all the studies of organs and tissues, in cellular and subcellular structures at an interval ranging from 10 minutes (brain, spleen) to 60 minutes (pancreas) after death occurred. 3. The cessation of the process of protein renewal may be caused by changes in the shape?? of their molecules associated with the loss of biocatalytic activity. The degradation of biopolymers into their structural units occurs over a period of several hours after death. 4. At a temperature of 36-38 °C, 10-15 after death, the processes observed are virtually irreversible. None of the resuscitation measures applied at this temperature level restored life. 5. If the body is rapidly chilled to 20°C, starting less than 10-15 minutes after death from acute anoxia, and remains chilled for an interval which can be as long as 90 minutes, it is possible to reverse the molecular changes occurring at death, and also the processes of renewal of biopolymers. This can be accomplished by saturating the tissues with oxygen (by means of perfusion of chilled oxygenated blood). Several hours after resuscitation began, the molecular structure of proteins, as well as metabolic and physiological functioning characteristic of living animals were restored.

## OPERATIONAL MEDICINE

P316(8/86)\* Tishler VA, Yeremin AV, Stepantsov VI, Funtova II.  
**Evaluation of the physical work capacity of cosmonauts on the "Salyut-6" space station.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 31-35; 1986.

[5 references; none in English]

Operational Medicine; Human Performance, Physical Work Capacity, Remote Measurement; Cardiovascular and Respiratory Systems, EKG  
 Humans, Cosmonauts  
 Space Flight, "Salyut-6;" Countermeasures, Physical Exercise

**Abstract:** This study measured EKGs of the 3 "Salyut-6" crews during graduated physical exercise sessions on a bicycle ergometer and treadmill. EKGs were registered using a portable cassette tape recorder with anterior Neba leads attached to the cosmonauts' belts which transmitted recordings in the form of FM signals to ground control along communications channels. A value of the physical loading accompanied each 28-second segment of the EKG. Loading was described orally and recorded and transmitted on the same record. Additional ergometric parameters were also recorded and transmitted. In spite of marked individual differences in pattern, recordings generally indicated satisfactory adaptation of physical work capacity to weightlessness. The authors interpret this as corroboration of the efficacy of the program of physical training procedures. The recordings were also used to correct physical loadings for individuals demonstrating abnormal reactions to the loadings selected.

**Tables:** Table 1: Changes in heart rate during exercise on a bicycle ergometer on day 84 for cosmonaut K-3-1

Work rate, kg-m/min	Duration, min	Heart rate beats/min	Work rate, kg-m/min	Duration, min	Heart rate, beats/min
850	1	126	1200	3	150
650	1	120	1050	3	162
950	3	138	Rest	1	126
650	1	126	950	3	138
1050	4	144	Rest	1	120
650	1	108	850	3	132
750	3	120	750	1	126
850	3	120	Recovery	1	96
950	1	138		2	80
Rest	1	120		3	80
1050	3	144		5	90
Rest	1	132			

# OPERATIONAL MEDICINE

P316

Table 2: Changes in heart rate in cosmonaut K-3-1 during exercise on a bicycle ergometer on day 114 of space flight

Work rate, kg-m/min	Duration, min	Heart rate, beats/min
750	5	120
Rest	1	84
750	3	120
650	1	114
850	3	138
Rest	1	78
950	3	168
Recovery	3	84

Table 3: Combined data on work performed, work rate and heart rate during physical exercise on a bicycle ergometer at various stages during flight of prime crew 4

Time, days	Cosmonaut K-4-1			Cosmonaut K-4-2		
	Total work performed, kg-m	Mean work rate, kg-m/min	Maximum heart rate, beats/min	Total work performed, kg-m	Mean work rate, kg-m/min	Maximum heart rate beats/min
42-45	19600	750	143	36400	1100	155
70	21200	730	165	39600	1050	170
97	27800	960	165	43000	1130	170
134-135	26200	780	152	47000	1200	154
174	27300	880	140	45000	1150	150

## OPERATIONAL MEDICINE

P324(8/86)\* Neborskiy AT, Belkaniya GS.

### **Electrical conductivity of the skin in humans and monkeys.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 61-68; 1986.

[13 references; 1 in English]

Operational Medicine, Functional State; Biological Rhythms, Seasonal Rhythms; Reproductive Biology, Menstrual Cycle  
Humans, Men and Women, Sex Differences; Monkeys, Macaques and Rhesus, Species Differences  
Skin Conductivity, Acupuncture Zones

**Abstract:** Human subjects participating in this experiment were 46 healthy males and 53 healthy women, aged 18-40. Skin conductivity was measured by standard techniques in 24 acupuncture points on the right and left extremities. Parameters recorded included average of all points, average for upper and lower extremities, and for left and right sides. The difference between the maximum and minimum values for all points was taken as an indicator of the distribution of conductivity. Asymmetry was assessed by considering the ratios of upper to lower extremity and left to right side. Skin conductivity was measured every month for 1 year. For the women phase of menstrual cycle was noted. Skin conductivity was measured in nonanesthetized hamydras baboons and rhesus monkeys under the following conditions: with arms restrained (22 monkeys), under restraint in a prone position (25 monkeys), in a primate chair (8 monkeys), and in an immobilization cage (9 monkeys). Seasonal dynamics of skin conductivity was studied in baboons in the immobilization cage and in rhesus monkeys kept continuously in the primate chair. The studies showed an almost total correspondence in the topography of the skin zones with maximum electrical resistance in humans and monkeys. Healthy men and women showed little lateral or transverse asymmetry in the conductivity points studied; however, in some individuals there were considerable differences between the points of maximum and minimum conductivity. Both sexes showed considerable seasonal variation in conductivity. For males, minimum conductivity occurred in the winter and maximum in the summer, with the difference between average conductivity highly significant. Women in the first phase of their menstrual cycles showed minimum skin conductivity in the fall and maximum in the summer. In their second menstrual phase, the male pattern of maxima and minima occurred; however, the differences between maximum and minimum values were less pronounced. Women tended to show greater variability in maximum and minimum values and asymmetry than did men. Despite general similarity of skin conductivity patterns, the differences between men and women were substantial. Rhesus monkeys and baboons also showed similar, but not identical seasonal profiles. The differences between individual maximum and minimum points were considerably more pronounced for monkeys than for humans, i.e., the distribution of skin conductivity was less even for the monkeys. The authors ascribe this to the stress producing conditions of the monkey experiment. The authors recommend the further study of skin conductivity as an indicator of general functional state, and conclude that the similarity of conductivity profiles in humans and monkeys suggests that the monkey is an adequate model for such studies.

Table: Seasonal changes in the major parameters of skin conductivity profiles in humans and monkeys

## OPERATIONAL MEDICINE

P324

Figure 1: Anatomic/topographic correspondence of skin acupuncture zones on X-rays of the feet and hands in humans and monkeys

Figure 2: Skin conductivity profile in men and women in the first and second phases of the menstrual cycle

Figure 3: Skin conductivity profiles in rhesus macaques and hamyadras baboons in various seasons of the year

Figure 4: Skin conductivity profiles in rhesus macaques and hamyadras baboons under various restraint condition



Personnel Selection: See Human Performance: M90, M94; Neurophysiology: P339

#### PSYCHOLOGY

(See also: Cardiovascular and Respiratory Systems: P340, P331; Group Dynamics: P345; Human Performance: All Entries; Immunology: P311; Neurophysiology: P322, P335; Metabolism, P333, M89)

#### PAPERS:

P332(8/86)\* Eliava VM, Urmancheyeva TG.

**The effect of hypokinesia on performance of a [learned] food-obtaining response in monkeys.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 82-83; 1986.

[9 references; 1 in English]

Psychology, Learned Response

Primates, Rhesus

Hypokinesia, Immobilization Stress

**Abstract:** Subjects in this experiment were 3 male rhesus monkeys, aged 5-6 years. Before the beginning of the experiment, subjects were taught a food obtaining response triggered by an auditory signal (conditioned reflex). This response consisted of pushing a lever, running along an unstable platform to the food box, etc. Each session involved 20 3-second presentations of the auditory stimulus, with an interstimulus interval of 30 seconds. The experiment itself began when the monkey correctly performed the response on 100% of the trials in a session. The latency of the response (time between signal and pushing the lever) and motor reaction time (time between pushing the lever and opening the food box) were recorded. In the experiment proper, the monkeys underwent hypokinesia for 30 days; the animal was either confined in an immobilization cage, or restrained in a specially designed chair, either in vertical position or rotating horizontally (called clinostatic hypokinesia). The performance of the learned response was tested on days 10, 20 and 30 of the hypokinesia, and also on days 5, 11 and 15 after termination of clinostatic hypokinesia. Keeping the animals in an immobilization cage did not affect the performance of the response, although there were some sporadic changes in the temporal parameters. Similar results were obtained when the monkeys were kept in the primate chair in vertical position. Clinostatic hypokinesia led to substantial changes in performance. Although the monkeys responded emotionally to the signal, performance of the instrumental response was sharply impaired. One of the monkeys made no attempt to perform the response throughout the experiment, and the others only rarely performed the entire chain of actions. Latencies and reaction times were higher for these responses than baseline. During readaption to normal activity, performance of the learned response was gradually restored. The authors suggest that the experimental results show that growing emotional stress and changes in the afferent flows led to a substantial depression of the the central nervous system.

**Figures:** Figure 1: Effects of limited motor activity on monkeys' performance of a learned food-obtaining response

Figure 2: Effects of clinostatic hypokinesia on monkeys' performance of a learned food-obtaining response

## RADIOBIOLOGY

(See also: Metabolism: M89)

### PAPERS:

P346(8/86) Antonenko SG, Sanina OL, Chebotarev YeYe.

**The role of cyclic nucleotides and lipids in creating the radioprotective effect of ceruloplasmin.**

Radiobiologiya.

XXVI(1): 112-115; 1986.

[13 references; 5 in English]

Affiliation: R.Ye. Kavetskiy Institute for the Problems of Oncology, Ukrainian Academy of Sciences, Kiev

Radiobiology, Liver; Metabolism, Lipids, cAMP, cGMP

Rats

Radioprotective Agents, Ceruloplasmin, Human

**Abstract:** In this experiment outbred white rats, weighing 150-180 g., were irradiated with a sublethal (6.24 Gy) and lethal (7.2 Gy) dose of X-rays, at a dose rate of 0.55 Gy/min. Human ceruloplasmin was administered to some rats 1 hour before irradiation in a dose of 10 mg/kg. Subjects were sacrificed 1, 3 or 7 days after the development of radiation sickness. The concentrations of cAMP and cGMP in the livers of the rats were determined on the first day after irradiation using radiochemical methods. Radioactivity was measured and phospholipids, protein and cholesterol concentrations were determined. Irradiation was associated with significant increases in cAMP and cGMP levels in the livers, by a factor of 1.8 and 2.4 respectively for the sublethal (LD<sub>50</sub>) dose. Irradiation thus decreased the cAMP/cGMP ratio by a factor of 1.3. Administration of ceruloplasmin led to cAMP and cGMP levels 1.4 and 1.5 times those of untreated animals and cAMP/cGMP ratio approached normal. The effect of administering ceruloplasmin to irradiated animals was significant only for cGMP. Administration of human ceruloplasmin to irradiated rats also increased the concentration of endogenous ceruloplasmin compared to irradiated animals not receiving this globulin. A lethal dose of radiation increased concentration of cAMP in the liver by a factor of 1.8, and of cGMP by a factor of 2.8; the ratio of the former to the latter decreased by a factor of 1.4 compared to baseline. While ceroplasmin decreased these levels, they still were significantly above those of animals not irradiated. Administration of this globulin did not affect cAMP/cGMP ratio of animals receiving a lethal dose of X-rays. Effects of the experimental treatments on levels of phospholipids and cholesterol in the liver are shown in the table below. The authors conclude that sublethal and lethal irradiation leads to significant changes in the concentration of lipids in the livers of rats. The changes noted in the concentration of cAMP at various periods after irradiation are correlated with decreases in phospholipids, suggesting mediated regulation of lipid metabolism. The administration of exogenous ceruloplasmin to some extent prevents alterations in the concentration of cyclic nucelotides and lipids in the livers of irradiated rats, as indicated by the normalization of cAMP/cGMP and cholesterol/phospholipid ratios. These results suggest that cyclic nucleotides and lipids participate in the compensatory mechanism involved in the radioprotective effect of ceruloplasmin.

# RADIOBIOLOGY

P346

Table: The effect of ceruloplasmin on lipid concentration in the liver of rats irradiated with X-rays at doses of 6.24 and 7.2 Gy

Control Animals	Irradiated Animals		
	Days after Irradiation	Without Ceruloplasmin	With Ceruloplasmin
	Phospholipids, ug per mg protein, 6.24 Gy		
7.1	3	4.7*	4.4
	7	4.6	6.4**
	Cholesterol, ug per mg protein, 6.24 Gy		
28.2	3	45.6*	49.2
	7	45.7*	28.7**
	Molar ratio of cholesterol/phospholipids, 6.24 Gy		
0.3	3	0.81	0.87
	7	0.84	0.37
	Phospholipids, ug per mg protein, 7.2 Gy		
7.1	1	3.8*	5.3**
	Cholesterol, ug per mg protein, 7.2 Gy		
28.2	1	45.6*	18.8**
	Molar ratio of cholesterol/phospholipids, 7.2 Gy		
0.33	1	0.68	0.29

\* differs from control,  $p < 0.05$

\*\* differs from irradiated,  $p < 0.05$

Figures: Figure 1: The effect of human ceruloplasmin on the concentration of cAMP and cGMP in the livers of rats on day 1 after irradiation

Figure 2: Changes in the value of the cAMP/cGMP ratios on day 1 after irradiation, with and without administration of ceruloplasmin

## RADIOBIOLOGY

P356(8/86) Gabitov VKh, Pukhov VV, Grishukova OV.

**[Quantitative description of] radiation damage to the intestine, bone marrow and lymphoid tissue of rats induced by prolonged irradiation with gamma rays after prophylactic administration of ATP.**

Zdravookhraneniye Kirgizii.

1986(2): 34-37.

[No references]

Affiliation: Department of Operational Surgery and Topographic Anatomy,  
Central Scientific Research Laboratory, Kighiz State Medical Institute

Radiobiology, Radiation Damage; Gastrointestinal System, Small Intestine;  
Hematology, Bone Marrow, Lymph Tissue

Rats

Gamma Irradiation; Countermeasures, ATP

**Abstract:** ATP has been found to have a radioprotective effect with low doses of radiation. The present study was designed to investigate whether radiation damage to intestines, bone marrow and lymphoid tissue is lessened by administering ATP before irradiation. Subjects of the experiment were 114 white rats weighing 100-150 g. ATP in a dosage of 350mg/kg was administered intramuscularly 20 minutes before total body prolonged irradiation with gamma rays in a dosage of 9 Gy (source Cs<sup>137</sup>; dose rate 0.5 Gy/hr). Control rats received a placebo injection of saline solution and identical irradiation treatment. Rats in both groups were sacrificed on days 3, 7, 15 and 30 after irradiation. Specimens of the small intestine were removed for morphological examination. The number of regenerating intestinal glands, mitotic activity in the cells of the intestinal epithelium, and the relative proportion of goblet-shaped cells among the cells of the epithelium and villi were recorded. The cell density in the thymus, spleen and bone marrow was measured, along with concentrations of hemoglobin and blood cells. The administration of the preliminary dose of ATP did not materially alter radiation damage to the intestine (duodenal, jejunum or ileum); however at certain time intervals, ATP was associated with diminished effects of radiation on regenerating cells and mitotic activity. No clear protective effects were found on bone marrow, blood, thymus and spleen cells.

**Tables:** Table 1: Number of regenerating epithelial cells of the small intestine at various intervals after irradiation with gamma rays

Table 2: Effects of preliminary administration of ATP on mitotic activity of various portions of the small intestine of rats after prolonged irradiation with gamma rays

Table 3: The effect of prophylactic administration of ATP on change in various parameters of hemopoietic and lymphoid tissue after prolonged irradiation with gamma rays

## RADIOBIOLOGY

P357(8/86) Eyduş LKh, Veksler AM, Korystov YuN, Kublik LN, Levitman MKh.  
**On the effects of post-irradiation hypoxia on potential cell damage.**

Radiobiologiya.

XXVI(2): 243-247; 1986.

[7 references; 2 in English]

Affiliation: Institute of Biological Physics, Pushchino, USSR Academy of Sciences

Radiobiology, Cell Damage

Microbiology, Prokaryotes; Cytology, Eukaryotes

Hypoxia, Postirradiation

**Abstract:** This study investigated the possibility of increasing the reproductive death of cells after a single exposure to radiation by subsequently incubating the cells in a hypoxic medium. The method used distinguished between the inhibiting effects of post-irradiation hypoxia on repair of radiation damage and on realization of that potential cell damage. Three types of cells were used: cell cultures from Chinese hamsters, *E. coli* B bacteria, and a solid form of Ehrlich's adenocarcinoma. Figure 1 (q.v.) shows the effects of hypoxia occurring at varying intervals after irradiation on the survival rate of Chinese hamster cells as revealed by their colony forming capacity. It is clear that hypoxia occurring immediately after irradiation decreases the post-irradiation survival rate by a factor of 4 - 5. As the time interval between irradiation and hypoxia increases, survival rate also increases (due to repair) approaching that of cells incubated in air after irradiation. The decrease in survival attributable to immediate post-irradiation hypoxia demonstrates that the inhibitory effect of hypoxia is not confined to a temporary delay in recovery. This is further confirmed by the effects of length of exposure to hypoxia on cell death. Results of exposure to hypoxia at various intervals after gamma irradiation are completely analogous when the experimental cells are those of *E. coli* B bacteria, (i.e. the maximum effect occurs when hypoxia follows directly after irradiation). The authors conclude that short-term (1-1.5 hr.) hypoxia, by depressing repair, facilitates the cellular potential damage in irradiated pro- and eukaryotic cells.

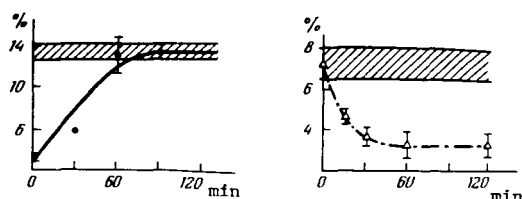


Figure 1: Survival rate of fibroblasts from Chinese hamsters receiving gamma radiation in air at a dose of 8 Gy (in a monolayer in the logarithmic phase of culture growth) as a function of time interval between irradiation and replacement of irradiation medium with an anoxic medium for 1.5 hrs.

Abscissa: time interval; Ordinate: survival rate.

Figure 2: Survival rate of Chinese hamster fibroblasts, exposed to gamma-irradiation in hypoxia at dose of 22 Gy as a function of duration of post-radiation incubation in hypoxia. Abscissa: hypoxia duration; ordinate: survival rate

## RADIOBIOLOGY

P358 Zhavoronkov LP, Sklobovskaya IE, Strelkov RB, Chizhov AY.

**Modification of radiation damage to hemopoiesis in rats by means of a hypoxic gas mixture.**

Radiobiologiya.

XXVI(2): 241-243.

[11 references; none in English]

Affiliation: Scientific Research Institute for Medical Radiology, USSR Academy of Medicine, Obninsk

Hematology, Hemopoiesis

Rats

Radiobiology, Radiation Damage; Countermeasures, Hypoxic Medium

**Abstract:** A total of 215 male Wistar rats, weighing 200-250 g, served as subjects in this experiment. Oxygen partial pressure in the spleens of healthy animals was measured polarographically. Both control and experimental groups were irradiated with gamma rays at a dose of 5.5-10.00 Gy and a dose rate of 0.0092 Gy/sec. Experimental animals were also exposed to the hypoxic mixture (containing 10% oxygen, 90% nitrogen) starting 3-4 minutes before the beginning of irradiation and terminating with irradiation. The criterion for assessing the radioprotective effect of this mixture was 30 day survival rate, morphology of peripheral blood in the 30-day period following irradiation, and well as cellular density in the bone marrow of the leg 3 days after irradiation. The hypoxic gas mixture facilitated survival of the irradiated animals at all dose levels used. The mixture decreased post-radiation pancytopenia in peripheral blood during the peak levels of radiation sickness. Cell density in peripheral blood recovered more rapidly in the rats protected by the gas mixture, and was essentially complete by 30 days after exposure. On day 3 after irradiation (the period of maximum marrow depletion), the number of nuclei containing cells in the bone marrow of the protected animals significantly exceeded that of the irradiated controls at 2 of the 3 dose levels. The authors conclude that the given hypoxic mixture, by creating hypoxia in the hemopoietic organs, has a radioprotective effect on the hemopoietic system. The resultant weakening of the bone marrow radiation syndrome leads to an increase in survival rate.

Table 1: Survival rate of rats protected by a hypoxic (10% oxygen) gas medium

Radiation dose, Gy	30 Day Survival Rate, %	
	Control	Hypoxic Mixture
7.0	65.0	90.0
8.5	37.5	75.0
10.0	0	32.5

## RADIOBIOLOGY

P359(8/86) Belyayev, IYa, Semakin AB, Grigorova NV, Akif'yev AP.  
**Cytogenetic analysis of the mechanisms underlying radiation induced chromosome aberrations in Crepis capillaris cells. Reproduction of aberrations induced by exposure to gamma-quanta, FUdR or their combination during the G<sub>2</sub> stage of the second nuclear cycle.**

Radiobiologiya.

XXVI(2): 175-179; 1986.

[13 references; 10 in English]

Affiliation: Moscow Institute of Engineering Physics; Institute of Chemical Physics, USSR Academy of Sciences, Moscow.

Genetics, Chromosome Aberrations; Cytology

Botany, Crepis capillaris

Radiobiology, Gamma-quanta, FUdR

**Abstract:** In this experiment sprouting seeds of Crepis capillaris were irradiated with <sup>60</sup>Co gamma quanta (dose 4 Gy, dose rate 2.5 Gy/min) 29 hours after moistening. Most of the seeds had been placed on a filter containing a solution of FUdR (5-fluorine-2-deoxyuridine), an inhibitor of DNA synthesis, and colchicine 25 minutes before irradiation. Some sprouts were fixed and analyzed cytogenetically for chromosome aberrations 3 hours after irradiation, while they were in the G<sub>2</sub> stage of the first K-mitosis. Others were removed from the colchicine and allowed to reach the G<sub>1</sub> phase of the second nuclear cycle. These cells were either incubated in thymidine until fixation 49 hours later or were incubated for 4 hours in water or FUdR and then in thymidine for 45 hours. Colchicine was added 4.5 hours before this fixation. Concentrations of FUdR, thymidine and colchicine were 10 ug/ml, 5 ug/ml and 100 ug/ml respectively. Aberrations were examined during the metaphase. Results are presented in Tables 1 and 2. The incomplete chromatid exchanges induced by gamma irradiation during the G<sub>2</sub> phase in the plant meristem, become complete in the second nuclear cycle. The addition of FUdR during irradiation causes eliminates the exchange aberrations. However, during the second nuclear phase, chromosome exchanges do occur even when FUdR has been added. Breaks induced by the introduction of FUdR in the G<sub>2</sub> phase no longer occur in the next nuclear cycle.

Table 1. Cytogenetic effects irradiation and FUdR on cells undergoing the first mitosis after exposure

Cells exposed in G <sub>2</sub> phase to:	Diploid metaphases analyzed	Number of aberrations per 100 cells					Total Chromatid Exchanges
		Upd	Up	Ud	Asymmetric chromatid translocations btwn: homologs nonhomologs		
Gamma-quanta	1199	2.17	1.08	1.83	0.83	4.08	12.18
Gamma-quanta and FUdR	441	--	0.26	--	--	0.45	0.68
FUdR	622	--	--	--	--	--	--
Control	1083	--	--	--	--	--	--

# RADIOBIOLOGY

P359

Table 1 continued

Cells exposed in G <sub>2</sub> phase to:	NU	Chromatid Deletions	Gaps	Isogaps
Gamma-quanta	1.17	5.25	3.36	0.19
Gamma-quanta and FUdR	4.31	10.43	29.65	3.78
FUdR	3.22	10.13	24.76	11.58
Control	--	--	0.28	0.09

Table 2. Reproduction of aberrations induced in the G<sub>2</sub> phase in the second nuclear phase

Cells exposed in G <sub>2</sub> phase of the first and G <sub>1</sub> phase of the second nuclear cycle to:	Tetraploid metaphases analyzed	Dicentricism between: homologs nonhomologs		Total Chromosome Exchanges
Gamma quanta in G <sub>2</sub>	611	6.06	2.95	11.13
Gamma quanta & FUdR in G <sub>2</sub>	629	5.25	3.34	10.33
Gamma quanta in G <sub>2</sub>				
FUdR in G <sub>2</sub> & G <sub>1</sub> *	770	5.32	3.64	11.04
FUdR in G <sub>2</sub>	549	0.18	--	0.18
FUdR in G <sub>2</sub> & G <sub>1</sub> *	203	--	0.99	0.99
Control	1091	--	--	0.18?

Table 2 continued

Cells exposed in G <sub>2</sub> phase of the first and G <sub>1</sub> phase of the second nuclear cycle to:	Chromosome deletions	Isogaps	Chromatid deletions & Gaps	Chromatid exchanges
Gamma quanta in G <sub>2</sub>	2.95	0.98	0.65	0.16
Gamma quanta & FUdR in G <sub>2</sub> *	4.29	--	0.48	1.43
Gamma quanta in G <sub>2</sub>				
FUdR in G <sub>2</sub> & G <sub>1</sub> **	4.03	1.27	1.30	1.17
FUdR in G <sub>2</sub>	0.73	1.64	2.91	--
FUdR in G <sub>2</sub> & G <sub>1</sub> **	2.96	--	2.46	--
Control	0.18	0.64	1.19	--

\*, \*\* - two rows of each table have same label, probably a misprint.



## RADIOBIOLOGY

P360(8/86) Belyayev, IYa, Semakin AB, Grigorova NV, Akifyev AP.  
**Cytogenetic analysis of the mechanisms underlying radiation induced chromosome aberrations in Crepis capillaris cells. Combined effects of gamma radiation and FUdR in the G<sub>2</sub> phase.**

Radiobiologiya.

XXVI(2): 180-184; 1986.

[5 references; 1 in English]

Affiliation: Moscow Institute of Engineering Physics; Institute of Chemical Physics, USSR Academy of Sciences, Moscow.

Genetics, Chromosome Aberrations; Cytology

Botany, Crepis capillaris

Radiobiology, Gamma irradiation, FUdR

**Abstract:** Crepis capillaris seeds were moistened and irradiated as described in the previous abstract. Thirty minutes before irradiation the sprouting seeds were placed on a filter containing either colchicine or colchicine and FUdR (5-fluorine-2-deoxyuridine) (10 ug/ml). Exposure to these solutions continued until fixation. The effects of FUdR were countered with thymidine. The sprouts were fixed 1, 2, 3, 4 or 5 hours after irradiation and aberrations were recorded in the metaphase. The frequency of incomplete exchanges within the range of radiation-induced exchange aberrations decreased as a direct function of time between irradiation and mitosis. FUdR blocks the formation of radiation-induced exchanges but does not increase the number of breaks. Addition of thymidine restores exchange aberrations to the previous level.

**Figure:** Incomplete exchanges as a function of interval between irradiation and mitosis.

**Table:** Range of chromosome aberrations induced by gamma quanta and FUdR

C-2

## RADIOBIOLOGY

### BOOK REVIEWS:

BR8(8/86) Kuzin AM, Kolomiytseva IK.  
Review of: Doskina GA.  
Endokrinnyye i metabolicheskiye aspekty luchevoy bolezny.  
[Endocrine and metabolic aspects of radiation sickness].  
Tomsk: Tomsk Universit'y; 1984; 221 pages.  
Radiobiologiya.  
XXVI(2): 283; 1986.

**Key Words:** Radiobiology, Endocrinology, Metabolism

The problem of the endocrine and corresponding metabolic disorders in an irradiated organism is of great interest to radiobiologists. For this reason, the publication of one of the few monographs on this topic, devoted mainly to the effects of ionizing radiation on the pituitary-adrenal system, the insulin producing apparatus and the major metabolic processes controlled by the endocrine system is particularly apposite. This book contains interesting factual information on the function of the pituitary-adrenal system and insulin producing apparatus in irradiated organisms, the metabolism of corticoids, the role of glucocorticoids and insulin in postradiation protein metabolism disorders, and other metabolic effects.

A large portion of the monograph is concerned with the analysis of the author's own experimental data, which is presented in all sections of the book and helps the author formulate a distinctive point of view on the issues discussed. The author analyzes a wide range of radiation and hormonal effects at the organismic, cellular and membrane levels; she then draws conclusions about the nature of endocrine disorders, consisting of the suppression of insulin production and the activation of the pituitary-adrenal system, and about the role of these disorders in the pathogenesis of radiation sickness. A great deal of attention is devoted to the analysis of the effects of countermeasures which normalize these hormonal-metabolic disorders, particularly taurine. It is noteworthy that the author's basic research has a clear practical goal -- the treatment of radiation sickness.

This book is of clear value and interest for radiobiologists,

## RADIOBIOLOGY

BR9(8/86) Gaziyeu AI.

Review of: Khanson KP, Komar VYe.

Molekulyarnyye mekhanizmy radiatsionnoy gibeli kletok

[**Molecular mechanisms of cell death induced by radiation**]

Moscow: Energoatomizdat; 1985; 152 pages.

Radiobiologiya.

XXVI(2): 283-284; 1986.

NB: This book was abstracted in Digest Issue #5 as M60.

**Key Words:** Radiobiology, Cell Death, Cytology, Genetics

The book under review combines data on the molecular mechanisms of the two major types of post-radiation cell death -- reproductive and interphase. This topic is relevant to one of the most urgent problems in contemporary radiobiology, the diagnosis and treatment of radiation damage, and the development of a scientific basis for radiation therapy for malignant tumors.

The book consists of nine chapters. The first chapter considers the general biological principles of cell death, with the difference in the two types discussed in detail. The contribution made by the different types of cell death to radiation-induced cell damage is evaluated. The next four chapters are devoted to reproductive cell death. An analysis is performed of the major quantitative models for this radiobiological phenomenon. The experimentally derived data is relevant to the kinetics of cell proliferation after irradiation and the morphological manifestations of inactivation of their reproductive capacity. The role of changes in DNA synthesis in disruption of proliferation and cell death after irradiation is considered separately. It is well known that the major cytogenetic manifestation of reproductive cell death involves chromosomal aberrations. A separate chapter describes these chromosome aberrations. In keeping with the book's theme, the most detailed consideration is given to the problem of the role of molecular disorders of cell genomes and DNA repair lethal, potentially lethal and sublethal damage. The relationships among the various types of DNA structural damage and radiobiological effects on the cellular level are evaluated.

The next four chapters of the monograph examine the problem of postradiation interphase death of nondividing cells. The phenomenology of this type of death, its temporal and dose-related characteristics, and approaches to the modification of this radiobiological effect are described in detail. The question of the relationship of interphase and reproductive cell death, which has received little attention in the literature, is examined. Next the authors present a detailed discussion of the role of metabolic and structural changes of macromolecules and cell membranes in the mechanism underlying interphase death; in particular, the significance of chromatin degradation, DNA repair, synthesis and maturation of RNA, protein synthesis, and energy supply to cells. Existing theories about the occurrence of this phenomenon are examined.

## RADIOBIOLOGY

BR9

One of the authors (K.P. Khanson) has developed an original genetic hypothesis concerning postradiation cell death, which approaches this phenomenon as an active genetically controlled process. Without going into the details of this hypothesis, which is laid out in Chapter 9 of the monograph, it should be noted that it provides a complete explanation of the experimental facts which have been obtained in this area.

In evaluating the monograph as a whole, it should be noted that it is written at a high scientific level with adequate citation of the existing literature on this issue, and that it is well illustrated with a large number of figures. The publication of this book is an important contribution to the development of molecular and cellular radiobiology and undoubtedly will stimulate further research on the problems of radiative cell death.

**SPACE BIOLOGY AND MEDICINE**

**PAPER:**

P336(8/86)\* Rozhkov SA, Kara-Murza SG.

**A comparison of the biographic citations used by authors of the journals "Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina" and "Aviation, Space and Environmental Medicine."**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 93-95; 1986.

[3 references; 1 in English]

**Abstract:** This study compared the sources cited by authors in the Soviet journal "Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina" [Space Biology and Aerospace Medicine] (KBAM) and its American counterpart "Aviation, Space and Environmental Medicine (ASEM)." The first comparison involved compiling the 15 most cited sources in 1982 for each journal. The sources for ASEM were:

- ASEM itself (42.5%);
- Journal of Applied Physiology (% not cited);
- American Journal of Physiology (5.6%);
- New England Journal of Medicine (% not cited);
- Journal of the American Medical Association (3.3%);
- Circulation (% not cited);
- Journal of Physiology (London) (2.7%);
- Acta Otolaryngologica (ca. 2.6%);
- Annals of the New York Academy of Sciences (ca. 2.6%);
- American Heart Journal (2.4%);
- British Medical Journal (ca. 2.4%);
- Lancet (ca. 2.3%);
- Circulation Research (2.2%);
- American Journal of Cardiology (ca. 2.2%);
- Federation Proceedings (2.1%).

The sources for KBAM were:

- KBAM itself (44.1%);
- ASEM (11.3%);
- Problemy Kosmicheskoy Biologii (Problems in Space Biology; a series of collections and monographs) (% not cited);
- Izvestiya AN SSR (Seriya biologicheskaya) (News of the USSR Academy of Sciences (Biological Series) (7.1%);
- Journal of Biological Chemistry (ca. 4+%);
- Aviatsionnaya i Kosmicheskaya Meditsina (Aviation and Space Medicine, Proceedings of a 1969 conference) (3.9%);
- Life Science Space Research (Proceedings of COSPAR sessions) (ca. 3.2%);
- Vliyaniye dinamicheskikh faktorov komicheskogo poleta na organism zhivotnykh (The Effect of Dynamic Flight Factors on the Bodies of Animals, Book published 1979) (ca. 3%);
- Byulleten' Eksperimental'noy Biologii i Meditsina (Bulletin of Experimental Biology and Medicine) (2.8%);
- Voyenno-meditsinskiy Zhurnal (Journal of Military Medicine) (ca. 2.8%);

P336

Doklady AN SSSR (Reports of the USSR Academy of Sciences) (ca. 2.5%)  
 Kosmicheskiye Polety na Korablyakh "Soyuz": Biomeditsinskiye Issledovaniya (Space Flights on the Soyuz Spacecraft: Biomedical Research, Book published 1976) (2.5%);  
 Laboratornoye Dela (Laboratory Affairs) (2.5%);  
 Osnovy Kosmicheskoy Biologii i Meditsiny (Principles of Space Biology and Medicine, Book published jointly with US, 1975) (2.5%);  
 Radiobiologiya (Radiobiology) (2.5%).

The overlap between the citations is 11.3%, attributable solely to the citation of ASEM by writers in KBAM. The authors state that this overlap is relatively low and that other comparable Soviet and American medical and biological journals (e.g., Journal of Organic Chemistry and its counterpart, or Cancer Research and its counterpart), show overlaps of 40-50%. However, they fail to discuss the fact that the two journals are not exact counterparts, since KBAM focuses on biology and medicine, while ASEM is devoted primarily to medicine. Other suggestive facts about this comparison not discussed by the authors, include the fact that Soviets cite works published in English fairly frequently, while none of the most frequently cited works in ASEM are Soviet publications. Soviets writing in KBAM are much more likely to cite monographs or bound proceedings in their papers than are writers in ASEM. Apart from differences due to KBAM's coverage of biology as well as medicine, ASEM writers appear to be more specifically focussed on the cardiovascular system than writers in KBAM. The authors compared the citation overlap between the two journals in the years prior to 1982 and found that it had decreased steadily from a level of 25% in 1979. They attribute this decline to a shift away from journal (e.g., Physiological Journal of the USSR) with broader coverage to citations of specialized journals and bound volumes (presumably, on the part of KBAM writers).

Another indicator analyzed was the "age" of citations in the 2 journals over the period 1976 - 1982. Citations in KBAM were further subdivided into "Soviet" and "foreign" for the purposes of this analysis. Over the period studied, 30.3% of Soviet citations in KBAM, 56.7% of foreign citations in the same journal, and 40.4% of citations in ASEM were over 10 years old. The authors cite with concern a tendency for mean citation age to increase over the period studied, particularly with regard to foreign citations in KBAM. However, this tendency is not obvious in the data they cite (See Table 2).

# SPACE BIOLOGY AND MEDICINE

P336

Table 1: Citations in KBAM and ASEM oriented to specific areas

Year	Percent of citations of specialized works among the most frequently cited works	
	KBAM	ASEM
1976	62.6	38.9
1977	73.0	50.3
1978	72.8	43.6
1979	69.9	44.8
1980	76.2	46.8
1981	69.0	44.6
1982	80.6	42.5
-----		
Mean	72.0	44.4

Table 2: Percent of bibliographic references to works published 10 or more years previously among the 15 most frequently cited sources

Year	KBAM		ASEM
	Soviet	Foreign	
1976	23.8	47.4	35.9
1977	23.7	56.0	36.2
1978	32.8	70.2	41.5
1979	36.7	57.4	43.1
1980	40.4	50.5	39.8
1981	23.3	59.8	42.7
1982	31.4	55.6	43.8
-----			
Mean	30.3	56.7	40.4

Figure: Comparison of the structure of bibliographic citations in KBAM and ASEM in 1982

## SPACE BIOLOGY AND MEDICINE

P337(8/86)\* Gazenko OG, Gurovskiy NN, Gyurdzhian AA.

**Space biology and medicine on the occasion of the 25th anniversary of the first manned space flight by Yuriy Alekseyevich Gagarin.**

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(3): 4-12; 1986.

**Abstract:** In this very general article the authors review the accomplishments of Soviet space biology and medicine over the past 25 years. Four factors are described as influencing the rapid and successful development of this field: the solid theoretical foundations of Soviet biology and medicine (the names of Pavlov, Vernadskiy and Orbeli are cited here); the successful development of aviation and rocket technology in the USSR; the arsenal of methods, devices and experience accumulated by aviation medicine; and, finally, the enthusiasm of the practitioners of these fields. The rate of development of this field can be inferred from the number of sources published over consecutive 5-year periods pertaining to the biomedical and social psychological problems of space flight. Approximately, 4700 such sources were published in 1961 to 1965; over 8200 in 1966-70 and ca. 10,000 in 1971-1975. Some of the accomplishments of space biology and medicine cited by the authors as having importance extending beyond the space program are: enhancement of knowledge about the adaptive capacity of man and animals (particularly of the cardiovascular system); understanding of the role of gravity in evolution; development of new methods and devices for radiation protection and data on the chronic effects of natural radiation; greater impetus for the study of the biological effects of all extreme factors; results from study of the effects of gravity that are of direct relevance to clinical biomechanics, traumatology, orthopedics, and sport and forensic medicine; development of methods of protection and norms with applications in industrial hygiene and treatment of occupational illnesses; clinical offshoots of the study of fluid shifts in space; improved understanding of normal and pathological hemodynamics; formulation of generalizable requirements for sanitary and hygienic aspects of the living environment; development of means of protection against the effects of harmful and toxic substances in the environment; improvement of methods and devices for locating personnel lost in harsh environments; improved knowledge of the psychophysiological capacities of humans and their physiological and hygienic requirements; impetus for the rapid development of ergonomics and human performance sciences; better understanding of the nature and consequences of psychological stress, and fatigue resulting from task performance; development of standards for flight schedules for pilots; better knowledge of the effects of prolonged exposure to social and physical isolation, as well as to restricted information, stimulation, and motor activity, leading to development of recommendations for improving psychological support for flight crews and the psychological aspects of crew composition; improved methods of crew selection and training; results of direct interest in areas such as determination of limits and criteria for identifying pathologies, functional disturbances and prepathological states, as well as normal ranges of fluctuations of physiological parameters for individuals and groups; improved habitability for living and working environments; development of rapid methods for performing medical and biological research; development of a number of new medical diagnosis tools (e.g., volume oscillography, plethysmography, ultrasound scanning); generation of new provocative stress tests with a wide range of uses outside the space program.



ENGLISH TRANSLATIONS OF SOVIET SPACE LIFE SCIENCES BOOK AVAILABLE TO OUR  
READERS

We have recently learned of translations of two Russian books in space life sciences which are, or soon will be, available and which are certain to be of interest to many of our readers. For further information, NASA personnel should contact: NASA Headquarters, Scientific and Technical Information Branch (Code NIT-4), at (202) 453-2912. Other readers should direct inquiries to:

Mrs. Ildiko Nowak, Chief  
The National Translation Center  
The John Crerar Library of the University of Chicago  
5730 South Ellis Avenue  
Chicago, Illinois, 60637  
(312) 962-7060

We would like to belatedly express appreciation on behalf of ourselves and our readers to Mr. Tim Rowe of NASA's Scientific and Technical Information Facility, who has brought the existence of these and previous English translations cited in the Digest to our attention.

The two books are:

Sytnik KM, Kordyum YeLm and Nedukha, YeM, et al.  
**The Plant-Cell with Changes in Geophysical Factors.**  
Translation of: "Rastitel'naya kletka pri izmenii  
geofizicheskikh faktorov." Kiev: Naukova Dumka; 1984; 366  
pages (in English). Abstracted as M16; in Issue 2 of the  
Digest.

Kubasov VN, Taran VA and Maksimov SN.  
**The Professional Training of Cosmonauts.**  
Translation of: "Professional'naya podgotovka kosmonavtov."  
Moscow: Mashinostroyeniye; 1985; 401 pages (in English).  
Abstracted as M67; in Issue 6 of the Digest.

The list of medical procedures which can be performed on Soviet spacecraft on the next page comes from the Kubasov, et al. book.

MEDICAL PROCEDURES PERFORMABLE ON SOVIET SPACECRAFT  
(From: Kubasov, et al., The Professional Training of Cosmonauts.)

Note: We have edited the available translation.

I. Diagnostic methods recommended for utilization by the crew of a spacecraft.

- Determining sensitivity to microbes
- Determining hemoglobin
- Measuring blood pressure:
  - arterial
  - peripheral venous
- Measuring temperature
- Electrocardiography
- Analyzing cardiac function:
  - at rest
  - during physical exertion
- Analyzing response of cardiovascular system to simulated hydrostatic pressure
- Measuring reaction of circulatory system to graded physical exercise
- Echocardiography
- Analyzing anatomical-function by ultrasound
- Measuring body mass
- Measuring changes in lower leg volume
- Microbiological analysis
- Electroencephalography
- Analysis of blood chemistry
- X-ray examination
- Evaluating state of skin in oral cavity
- Measuring levels of microimpurities in atmosphere of crew compartments
- Analyzing diurnal patterns of bioelectric activity of the heart
- Ballistocardiographic analysis
- Measuring radiation dosimetry in crew compartments
- Evaluating biological effects of ultraviolet solar radiation
- Biological analysis of urine for evaluating fluid-electrolyte control
- Analysis of carbohydrate metabolism
- Evaluation of color vision acuity
- Analysis of depth perception and visual resolution at various levels of illumination
- Comparison of tracking performance at beginning and end of flight
- Evaluation of tolerance to altered sleep/waking schedules
- Study of therapeutic and prophylactic effects of pharmacological countermeasures

II Medical procedures performable in space if the crew includes a physician:

- Clearing air passages:
  - through oral cavity
  - through intubation
  - tracheotomy
  - laryngeal puncture
- aspiration:
  - of blood or fluid accumulation
  - thoracentesis
  - paracentesis
- Blood transfusion (from crew donor)
- Application of cold to injury
- Administration of drugs:
  - orally
  - topically
  - intramuscularly
  - intravenously
- Applying dressing to eye
- Removing foreign body from eye, nose or throat
- Recompression
- Treatment of hypothermia
- Immobilization:
  - short-term
  - long-term
- Incision for drainage
- Intravenous feeding
- Flushing skin, eyes or upper respiratory tract
- Laparotomy
- Use of gastric tube for aspiration or feeding
- Administering oxygen:
  - at normal pressure
  - at increased pressure
- Tissue [auto] graft
- Aspiration:
  - from gastrointestinal tract
  - from respiratory tract
- Application of tourniquet
- Trepanation
- Catheterization of bladder:
  - repeated
  - permanent
- Treatment of wounds:
  - antiseptic
  - medical
  - vascular ligation
  - suturing
  - dressing

CURRENT TRANSLATED SOVIET LIFE SCIENCE MATERIALS AVAILABLE TO OUR  
READERS

Translations of recent Soviet publications, including those of interest to specialists in space life sciences, are published by Joint Publications Research Service (JPRS). JPRS publications may be ordered from the National Technical Information Service (NTIS), Springfield, Virginia 22161. The phone number of NTIS is (703)-487-4600 and telephone orders are encouraged. Each individual issue of a JPRS report must be ordered separately. Prices depend on number of pages; a recent issue of Space Biology and Aerospace Medicine, for example, cost \$16.00. When ordering, it is recommended that the JPRS number, title, date and author, if applicable, of publication be cited. An order takes 9-30 days to arrive. Rush orders are possible, but involve an additional charge. There is a significant and variable lag period between the time a JPRS publication is completed and the time it is orderable from NTIS.

Two JPRS USSR Report Series appear of particular interest to NASA life scientists. These are: 1) Space, and 2) Life Sciences: Biomedical and Behavioral Sciences. In addition, JPRS translates the entire issue of the bimonthly Space Biology and Aerospace Medicine. As a service to our readers we will regularly provide publication information for these reports and cite the titles of articles selected as particularly relevant to NASA. Translations of titles are those of JPRS. JPRS entries marked with \* were previously abstracted in this Digest.

USSR REPORT: LIFE SCIENCES  
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-86-011      17 JUNE 1986

Selected Contents:

Aircraft Life-Support Systems on View

(Bogoraz A; Newspaper Article; 1 page)

Physiology and Assembly Line Work

(Rylov A; Article Abstract; 1 page)

Factors Affecting Psychophysiological Status of Arctic Seamen \*

(Stenko YuM, et al; Journal Article; 5 pages)

Effects of Hyperoxic Helium-Oxygen Gas Mixtures on Oxygen Uptake by  
Tissues of Albino Rats

(Nazarenko AI, et al.; Article Abstract; 1 page)

Individual Features of Bodily Reaction to Solar Heat

(Talanina LKh, et al.; Article Abstract; 1 page)

USSR REPORT: LIFE SCIENCES  
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBE-86-012

20 JUNE 1986

Selected Contents:

Mental Self-Regulation as Factor of Increasing Reliability of Power  
System Operators  
(L.A. Letikhova; Article Abstract; 1 page)

Hemopoiesis in Animals with Hyporegenerative Anemia Following High-  
Altitude Hypoxia  
(Almerekova AA; Article Abstract; 1 page)

USSR REPORT: LIFE SCIENCES  
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-86-013 (corrected) 29 JULY 1986

Selected Contents:

Effect of Polygradient Magnetic Fields on Some Physicochemical and  
Biophysical Characteristics of Plant Cells  
(Bondarenko, NF; Article Abstract; 1 page)

Determination of Fatty Acid Spectrum of Total Blood Lipids During  
Physical Exertion  
(Anikeyeva, SP, et al.; Article Abstract; 1 page)

USSR REPORT: LIFE SCIENCES  
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-86-014 31 JULY 1986

Selected Contents:

Metabolic Basis for Dietary Recommendations Under Alpine Conditions  
(Aldahev, AA; Article Abstract; 1 page)

Functional Changes in Cardiovascular System and Indices of External  
Respiration and Peripheral Blood in Acute Altitude Disease Patients  
(Khamzamulin GD, et al.; Article Abstract; 1 page)

Physical Performance Ability of Teenagers Under Conditions of Middle and  
High Elevations  
(Tenebaum AM, et al.; Article Abstract; 1 page)

USSR REPORT: LIFE SCIENCES  
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-86-017 19 August 1986

Selected Contents:

Effect of Ship Noise on Free Association Rate of Sailors on Prolonged  
Sea Duty  
(Volkov AA, et al.; Article Translation; 5 pages)

USSR REPORT: LIFE SCIENCES  
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-86-017 19 August 1986

Selected Contents:

Electrocardiographic Changes and Treatments of Cardiovascular Diseases  
under Middle-Alpine Conditions  
(Izmukhanov AK, et al.; Article Abstract; 1 page)

Influence of Sympathetic Nervous System of Animals on Erythropoiesis and  
Cell Composition of Blood Under High Altitude Conditions  
(Tiflis AYU, et al.; Article Abstract; 1 page)

1. Report No. NASA CR-3922(09)		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle  USSR Space Life Sciences Digest - Issue 8				5. Report Date October 1986	
				6. Performing Organization Code	
7. Author(s) Lydia Razran Hooke, Mike Radtke, Victoria Garshnek, Ronald Teeter, and Joseph E. Rowe, Editors				8. Performing Organization Report No.	
9. Performing Organization Name and Address  MATSCO 600 Maryland Avenue, SW Washington, DC 20024				10. Work Unit No.	
				11. Contract or Grant No. NASW-3676	
12. Sponsoring Agency Name and Address Office of Space Science and Applications National Aeronautics and Space Administration Washington, DC 20546				13. Type of Report and Period Covered Contractor Report	
				14. Sponsoring Agency Code EBM	
15. Supplementary Notes Lydia Razran Hooke, Mike Radtke, Victoria Garshnek, and Ronald Teeter: Management and Technical Services Company, Washington, D.C. Joseph E. Rowe: Library of Congress, Washington, D.C.					
16. Abstract This is the eighth issue of NASA's USSR Space Life Sciences Digest. It contains abstracts of 48 papers recently published in Russian language periodicals and bound collections and of 10 new Soviet monographs. Selected abstracts are illustrated with figures and tables. Additional features include reviews of two Russian books in radiobiology and a description of the latest meeting of an international working group on remote sensing of the Earth. Information about English translations of Soviet materials available to readers is provided. The topics covered in this issue have been identified as relevant to 33 areas of aerospace medicine and space biology. These areas are: adaptation, biological rhythms, biospherics, body fluids, botany, cardiovascular and respiratory systems, cosmonaut training, cytology, endocrinology, enzymology, equipment and instrumentation, exobiology, gastrointestinal system, genetics, group dynamics, habitability and environment effects, hematology, human performance, immunology, life support systems, man-machine systems, mathematical modeling, metabolism, microbiology, musculoskeletal system, neurophysiology, nutrition, operational medicine, personnel selection, psychology, radiobiology, reproductive biology, and space biology and medicine.					
17. Key Words (Suggested by Author(s)) space life sciences    space flight simulations aerospace medicine space biology USSR space flight experiments				18. Distribution Statement  Unclassified - Unlimited  Subject Category 51	
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 111	
				22. Price A06	